Popular Science

MONTHLY Founded 1872

March
1928
25 cents

In This Issue

Why the Navy Lost the S-4

All the New Discoveries and Inventions

For men who enjoy *doing* the job

Larger face lets your blows strike true; shorter neck gives better balance; knife-like claws pull any nail. It has power, accuracy and balance . . . and the screw wedge which re-tightens the handle when it loosens.
Model HF 81 1 lb. $1.50

All wood handles loosen from steady pounding and shrinkage, but only a Plumb can be tightened just by turning this patented screw-wedge.

For machinists, motorists and for heavy work around home. Oblong eye takes an over-size handle; head off-center gives more power to your blow; cone-shaped pein spreads rivets instead of mashing them.
No. HF 373 1 lb. $1.15
Heavier weights in proportion

YOU men whose sport is in making things and not in the things you've made—

Who would rather grip a high-grade tool than any steering wheel—

You men whose work-bench is your golf course . . . whose tools are your pals—for you Plumb Tools are made.

Grip the Nail Hammer! Feel that balance? . . . how it tunes itself to your swing? Every line of the handle, every curve of the head is designed to get that result.

Pull a headless nail; grip the slimmest brad. See how those claws take hold!

••

Or the Hatchet . . . there's a keen blade. Toughened through and through by a special tempering process. Slice a shaving . . . or sink the blade deep. It goes just where you aim it.

Or the Ball Pein . . . for your heavy work. You'll find Power there! The weight is placed off-center to give more drive to your blow. The pein spreads rivets instead of mashing them.

••

Special steel, heat-treated by Plumb's armor-plate process, gives this tool an edge that stays sharp. Plumb tempering gives it toughness and strength to stand all-around work. Plumb's screw-wedge gives it security, because you just turn the screw when the handle loosens.
No. 2962 . . . . . $1.60
Prices in Far West or Canada slightly higher

Every head a rust-proof ivory black. Every handle of sturdy hickory, double-tested, and stained an enduring red.

And never a loose handle or wobbly head to make your tool unsafe. For you just turn the patent screw wedge when a Plumb Handle loosens . . . and immediately it is tight again.

Fine tools—every one of them. Fine in design . . in finish—and in those small details that the tool lover knows.

Your hardware man has Plumb.

FAYETTE R. PLUMB, INC.
PHILADELPHIA, U. S. A.

WHAT IS NEW THIS MONTH

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March, 1928, Vol. 112, No. 3. Popular Science Monthly is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3.

Are You Abreast of the Times?

If you can't answer the questions below, turn to the page indicated

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How a *Big Load* Was Lifted *from* Harry Wilson's Mind

By WALLACE AMES, *Financial Editor*

THE family had finished its dinner early. Harry Wilson had about exhausted his evening paper and was ready for whatever might turn up. His wife was upstairs going through the nightly tussle with two lively youngsters, getting them stowed away to bed.

Ding-a-ling a-ling rang the telephone. Mr. Wilson answered. "Gee, I'd like to, Bob, but just hold the wire a minute while I check up with Vi."

"Oh, Vi!" Wilson called upstairs, "Bob Collins is on the 'phone. He and Nan want us to come over this evening. How about it?"

"Mercy, I wish we could, Harry," called his wife. "We always have a good time at the Collinses. But there is something I must get done tonight. Ask him to excuse us this time. Tell Nan I'll call her up tomorrow."

"What's the big rush job for tonight, Vi?" inquired her husband, as she came down stairs.

"Betty's new dress. I must get it finished so she can wear it at her birthday party tomorrow."

"Why, I thought Mrs. Bender was taking care of all your sewing," remarked Harry.

"She was over all day," explained Mrs. Wilson, "but there was so much to do she couldn't finish. Betty is so excited over this new dress that I want to finish it for her myself tonight.

"Mrs. Bender wanted to stay until the work was done. She's so willing, but I couldn't let her do it. She has three children of her own, you know. The youngest is only five. There is no one at home to look after them while their mother is out sewing and I hadn't the heart to let her stay after five.

"It's too bad Mrs. Bender has to be away from her children all day, but she must go out sewing to feed her family and keep a roof over their heads. I feel so sorry for her."

"According to neighborhood gossip," observed Mr. Wilson, "Mrs. Bender got a lot of insurance money when her husband died."

"She did," replied Mrs. Wilson, as her flying fingers were finishing button holes and sewing on buttons. "There was $10,000 and that *is* a lot of money. But the cemetery plot, burial expenses and other bills ate up over $2,000, and she invested the rest partly in vacant lots and partly in mining stock that didn't turn out so good.

"Mrs. Bender was telling me all about it this afternoon. The lots were supposed to be right on the road leading to the new bridge and the mining stock promised to pay 12%. The stock proposition turned out to be a fake and she will probably lose all she put in it. As you know, they finally changed the location for the new bridge. Some day Mrs. Bender will probably be able to sell her lots, but she will hardly get as much as she paid for them. In the meantime, she has to pay taxes and she is getting no income from her investment."

"That's tough," mused Harry. "But you'd think she'd have known better. I'll bet you wouldn't waste our insurance money like that."

"I hope not," said Vi, with semi-assurance, "but I remember when Mrs. Bender made her investments I agreed with her that she was making a clever deal. It is too bad she did not have someone with a wise business head to advise her."

"She should have known enough to make a safe 6% investment," said Harry, as though to dismiss the subject with a few words of wisdom.

"Yes," agreed his wife. "She thought something of that at the time, but 6% on the $8,000 she had left is only $40 a month and you can't support a family on that. So she thought in some way she had to make the money go farther."

"Too bad," said Harry, as he got out the cards for a game of solitaire.

But he could not get the subject of life insurance and that inexperienced mother's predicament off his mind. Thinking more of the future possibilities in his own family than of the cards, he overlooked many plays, finally lost interest in the game and gave it up.

"Vi, I can't get Mrs. Bender out of my mind, and for the first time since we were married, I am beginning to wonder what would happen to you and our kiddies if I should die."

"Nonsense, Harry, get such unpleasant thoughts out of your mind. You are perfectly healthy. Let's change the subject."

"No, let's not change the subject," insisted Harry. "Let's be serious.

"You know, I think we have both looked at this matter in the wrong way. We have been pretty careful and are getting along *(Continued on page 7)*

How a Big Load Was Lifted from Harry Wilson's Mind

(Continued from page 4)

nicely. Thanks to the building and loan we have over $4,000 paid on the house, my last deposit gave us over $900 in the savings bank, we have paid $3,800 on our 50 shares of preferred stock in the electric light company, Betty has $300 in the bank, Paul has over $200 and there's the $10,000 insurance. That seems like a lot of money. But just wait a minute while I do some figuring."

After Harry had worked with pencil and paper for a few minutes he resumed his discussion. "Here is our picture for the next few years. We must pay $83.33 on the house every month for six years more. And $75 a month for the next ten months before we own our public utility stock outright. Taxes and upkeep on the house are about $300 a year.

"If I should die, you ought to be in position to pay off the mortgage and pay up the stock so you wouldn't have to worry about them. Right now that would take about $5,900. What would be left, considering all the money you would have, including even the children's bank accounts?

"$10,000 insurance, stock worth about $4,500, savings $900 and the children's money $500 make not quite $16,000. So after paying up the mortgage and the stock, you would have about $10,000 left. That would bring in $50 a month at 6%. Right off the bat $25 of it would be eaten up by taxes and house repairs. That leaves only $25 for food, clothes, coal, educating the children and other necessary expenses.

"Gee, Vi, you'd be as bad off as Mrs. Bender," said Harry.

"Oh, we'd get along some way, but nothing like that is going to happen," Vi tried to reassure Harry.

"I am just as hopeful as you are, Vi, about the future, but just the same it would take a load off my mind to know that you were better provided for in case of the unexpected. And so," said Harry with credible determination, "I am going to get this fixed up right away.

"In fact, I guess I'll go over now and see Bob Collins myself. He is in the insurance business.

"I'll get him to help work out the right program for us. And I'll send Nan over here to keep you company as I probably won't get back until we have thrashed out all the pros and cons."

* * * * *

It was a long session that Wilson and Collins had together that evening, and one thoroughly (Continued on page 6)

How a Big Load Was Lifted from Harry Wilson's Mind

(*Continued from page 5*)

worthwhile. People sometimes regard their financial affairs as private. They don't like to talk about them to others. Perhaps it is because we like to make believe that we are better off than we really are. But they called a spade a spade that night discussing the facts just as they were and the result was a very sound and sensible insurance program for Harry Collins. In outline form it was as follows:

Immediate obligations in event of Wilson's death:

Sickness, burial and other expenses	$1,500
Retirement of mortgage (estimated)	5,000
Balance due on securities being purchased	750
Immediate cash outlay	$8,250

(*Continued on page 7*)

How a Big Load Was Lifted from Harry Wilson's Mind

(Continued from page 6)

To meet this outlay and provide something extra, Wilson's present $10,000 policy was reserved, to be paid in one sum. It was planned to invest whatever remained ($1,000 to $1,750 or more) in high-grade bonds as a sort of permanent emergency fund.

* * * * *

Estimated minimum monthly income needed by Mrs. Wilson to get along as a widow	$275
Average monthly dividends on public utility stock	25
Interest on savings bank balance	5
Income from invested balance of original insurance policy	5
Balance of monthly income to be provided by new insurance	240
Total monthly income from insurance and investments	$275

* * * * *

New insurance was taken on the "monthly income" plan which provided that $240 would be paid to Mrs. Wilson each month for 20 years (or to the children in the event of her death within that time).

In the event of Mr. Wilson surviving for 25 years, at which time he would be 60 and his children probably self-supporting, the cash surrender value of his insurance would purchase a life annuity for himself and Mrs. Wilson of about $1,400.

Instead of one large policy, several smaller ones were taken out with premiums evenly distributed through the year. The average monthly deposit after the first year was $75.

This premium item is not an expense to the Wilsons, but an investment, because, if the insured lives he and his wife will in later years enjoy an independent income from insurance.

The two most important features of the Wilson insurance program were (1) that he provided *adequately* for his family, and (2) after providing for immediate expenses he arranged for the insurance money to be paid as *monthly income.*

The figures used in this outline are approximate and necessarily general. Each case calls for its own figures and plans.

POPULAR SCIENCE MONTHLY recommends that you regard your insurance representative as a professional adviser. Let him help you work out your individual problem. More and more insurance is being taken out on this basis. And it pays.

Illustrated above is the proposed engineering group at New York University. The building on the right is already erected and it is here that the tests of the Popular Science Institute are conducted

Deciding What Tools Are *Good*

By
F. G. PRYOR, *Secretary*
Popular Science Institute of Standards

"IT IS a fine tool; it represents good value; it will give you satisfactory service,"—this is what the Popular Science Institute of Standards' insignia of approval tells you when you see it on a tool advertisement. Such statements mean much or little according to what lies in back of them and the tool user will rightfully ask, "How do you know that?"

As a matter of fact, the Institute had no easy task determining this and it took considerable time, work and study before it was felt to be in a position to speak authoritatively on the subject of tools.

In the first place, while the Popular Science Institute was fortunate in having some very prominent engineering experts on its staff and in having at its disposal the $350,000 Sage Research Laboratory testing equipment at New York University, it had little to go by in the matter of test methods and still less in the case of standards.

This meant two things. Test methods had to be worked out and in many cases equipment had to be specially designed for use in making such tests. There are machines like the Rockwell, Brinell and Scleroscope, for instance, that can be used in testing the hardness of the steel in a tool, but when it comes to putting a hammer through a test of so many thousand blows there is no machine that one can go out and purchase for the purpose. So, in a case like this, the Institute's testing experts had to devise an arrangement that would accurately serve, just as it was necessary to rig out an ingenious reciprocating machine that would put an automatic or spiral screw driver through the equivalent of several years of heavy everyday usage in only a few days' time.

Then, an even harder task confronted the Popular Science Institute of Standards when it came to gaging the test results and determining where to draw the line in the matter of approvals. The Institute's testing experts relied upon whatever could be found in Government bureaus and elsewhere, but the difficulty lay in the fact that they were not trying to set up any absolute standard that every tool or product must attain in order to be a good one, but were endeavoring to devise tests to suit the use to which each product is put.

The Popular Science Institute's tests are not perfect yet—not by a great deal—but just how far we have gone and just how worth while the work has been can be judged by the recognition that has come from highest sources.

The U. S. Bureau of Standards in Washington has recently appointed the Institute's director, Dean Collins P. Bliss of New York University, as a consulting mechanical engineer for their organization, and the belief has been expressed by officials of the Federal Specifications Board that the affiliation of the U. S. Bureau of Standards and the Popular Science Institute of Standards will result in mutual help and benefit.

Our Assistant Director in charge of tool testing is Major Carlos deZafra, Chief of the Testing Laboratory Section of the New York Ordnance District. This appointment means that all tools of the U. S. Army will be tested, prior to writing of specifications of purchase, in the Sage Laboratory where the Popular Science Institute's tests are conducted.

These tests are conducted for the benefit of POPULAR SCIENCE MONTHLY readers with no charge nor advertising obligation to manufacturers. A list of approved tools may be had by writing the Popular Science Institute, 150 Fourth Ave., New York, N. Y.

Radio is better with *Battery* Power

Why pay for waste space?

Buy the EVEREADY LAYERBILT

—it's every inch a battery

This is the Eveready Layerbilt, the unique "B" battery that contains no waste spaces or materials between the cells; the longest lasting of all Evereadys.

IN DRY cell "B" batteries made up of cylindrical cells more than one-third of the space is wasted. That's inevitable. No matter how closely you pack a group of cylinders, there always will be spaces between them. Usually these spaces are filled in with pitch or other substances, to prevent movement of the cells during shipment and breakage of the wires connecting cell to cell. Think of it—over a third of the space inside the ordinary battery is filled with inert packing material!

In the Eveready Layerbilt "B" Battery No. 486 there are no waste spaces between the cells and no useless materials. Instead of cylindrical cells, this extraordinary battery uses *flat* cells. It is built in layers and assembled under pressure into a solid block. Electrical connection between cell and cell is automatic, by pressure of the entire side of each cell against its neighbor.

The most surprising thing about this construction is that it actually makes the active materials more efficient. A given weight of them produces more current, and lasts longer, than the same amount when put in the cylindrical cell form. This was the unexpected result of researches into methods of utilizing the hitherto waste spaces. Scientists now know that the flat shape is the most efficient form for the cells in a "B" battery. No wonder the Eveready Layerbilt is the longest lasting and therefore most economical of all the Evereadys.

Only Eveready makes the Layerbilt. Its exclusive, patented construction is Eveready's greatest contribution to radio enjoyment, giving new economy and convenience to battery users. The Eveready Layerbilt, of course, provides Battery Power—silent, reliable, independent, guarantor of the best reception. For modern sets, use the Eveready Layerbilt.

Illustrated at the left is the cylindrical cell type of "B" battery construction. Note the waste space between the cells.

NATIONAL CARBON CO., INC.
New York UCC San Francisco
Unit of Union Carbide and Carbon Corporation

Tuesday night is Eveready Hour Night
East of the Rockies
9 P. M., Eastern Standard Time
Through WEAF and associated N. B. C. stations
On the Pacific Coast
8 P. M., Pacific Standard Time
Through N. B. C. Pacific Coast network

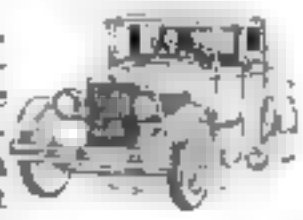
EVEREADY Radio Batteries *-they last longer*

The air is full of things you shouldn't miss

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Our Readers Say—

What Do You Say, Gus?

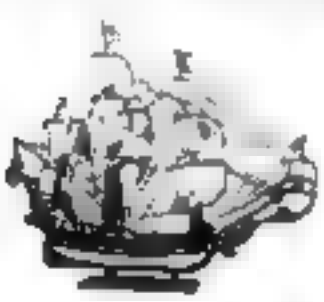


GUS and Joe, those inimitable garage experts who are with us each month, felt justified, a few issues ago, in roundly blaming the woman who "drives" from the back seat. Letters from many readers agreed with them. But listen to Mrs. L. S., of Walton, N. Y.

"Why must the wife sit in the back seat, anyway? From that position everything looks much more dangerous. Since learning to drive I have found that what looks like an unavoidable smash from the back seat does not remotely suggest one to the driver, and very rarely to the other occupant of the front seat. This is just a plea for a square deal for the woman."

A Place of Honor

"PERMIT me to take this opportunity to express my appreciation of Captain McCann's plans and directions for ship model building. Not only are these plans clear and correct in every detail, but they produce beautiful and artistic results. I presented a model of the Spanish galleon to a cousin who, among other gifts, received a new grand piano; and my Spanish galleon now has the place of honor on the piano."—W. C. R., South Pasadena, Calif.



What Hope for Inventors?

"I WAS surprised, recently, to read that Maurice Holland, of the National Research Council, says the independent inventor has seen his best days. Mr. Holland pointed out that less than five percent of the inventions in the Patent Office which receive commercial recognition are the products of men who labor single handed. And he concluded that the 'garret genius,' as he calls him, cannot hope to compete nowadays with the collective work of men in highly organized industrial research laboratories.

"Is this true? I doubt it. Count over the inventions which have given us most of our modern wonders. The telephone, electric light, automobiles, airplanes, wireless, the machinery of farm and factory—every one sprang from the hand of a lone worker, often struggling with poverty, but inspired by a great idea.

"Hired workers in great laboratories are necessary for the application of inventions to industry; but the greatest inventions themselves come from the labors of the 'garret genius.' Am I right?"—N. B. Y., Detroit, Mich.

The Debate Goes On

"PROHIBITION—Is It Good for Us?" in our January issue drew many letters from readers. For example, A. S., of Dwight, North Dakota, writes:

"I have in a most unbiased manner compared and analyzed the indictment of prohibition by Dr. Charles A. L. Reed, and the defense by Dr. Haven Emerson. Dr. Emerson brought forth twenty-nine major reasons why prohibition is a benefit to our nation. For each reason he offered unimpeachable evidence. Dr. Reed, on the other hand, failed to make a point.'

And then Dr. Reed won the debate by long odds," observes S. M. T., of Cleveland, Ohio. "Dr. Emerson uses the circumstantial evidence of general mortality rates to show that prohibition is good for us. His whole argument falls before the undisputed direct evidence of increasing deaths from poisonous prohibition liquor. And does he realize how many people are dying for a good drink?"

What Do You Think?

"I OBJECT to fiction in your magazine. Leave fiction to others. Some of your articles seem to be pretty good fiction, anyway."—R. T., Lincoln, Neb.

"The stories are interesting, instructive, and make the magazine more enjoyable than ever."—L. A. T., Peoria, Ill.

"Let's have more stories of the 'Bare Hands' type."—P. C. K., Minneapolis, Minn.

"POPULAR SCIENCE is not quite so popular at our home with the boys since you have introduced so much reading matter in the way of stories."—T. E. D., Cleveland, O.

Your idea of fiction science is excellent, and should prove immensely popular with the reading public."—C. E. R., Toronto, Canada.

"When there is so much bad fiction on the market, why do you have to add to it?"—S. M. T., Fargo, N. D.

"Your story, 'Midge', tells enough about the making of steel so that it holds a person's interest better than many articles could."—H. R., Edgerton, Wis.

Glad You Like It

"I HAVE a free mason ticket to the opera, and I go every week.

"I have a clock which I never need to wind, yet it strikes the correct time every day in the year.

"I follow all the ball games and boxing matches free without crashing the gate.

"I go to church every Sunday and never drop a dime into the plate.

"Every so often the President of the United States tells me his troubles.

In fact, I am quite a privileged citizen. And all because I built that POPULAR SCIENCE five-tube radio. I must say it has exceeded my fondest hopes."—J. L. M., Pittsburgh, Pa.

Apes and Ostriches

"I AM not a Darwin ape; neither are my friends," writes C. R., of Los Angeles, Calif., one of the readers who commented on Sir Arthur Keith's recent summary in POPULAR SCIENCE MONTHLY of the proofs of Darwinian theory. In the same mail S. L. T. wrote from Nashville, Tenn.

"Though I live in a state which has a law against the teaching of evolution, the clear explanation of the evidences for evolution contained in your article was convincing enough for me. As Dr. V. A. Noves, president of the American Association for the Advancement of Science, said recently, 'Evolution can only be doubted by an individual who, like an ostrich, buries his head in the sand out of dread that he may see something shocking.'"

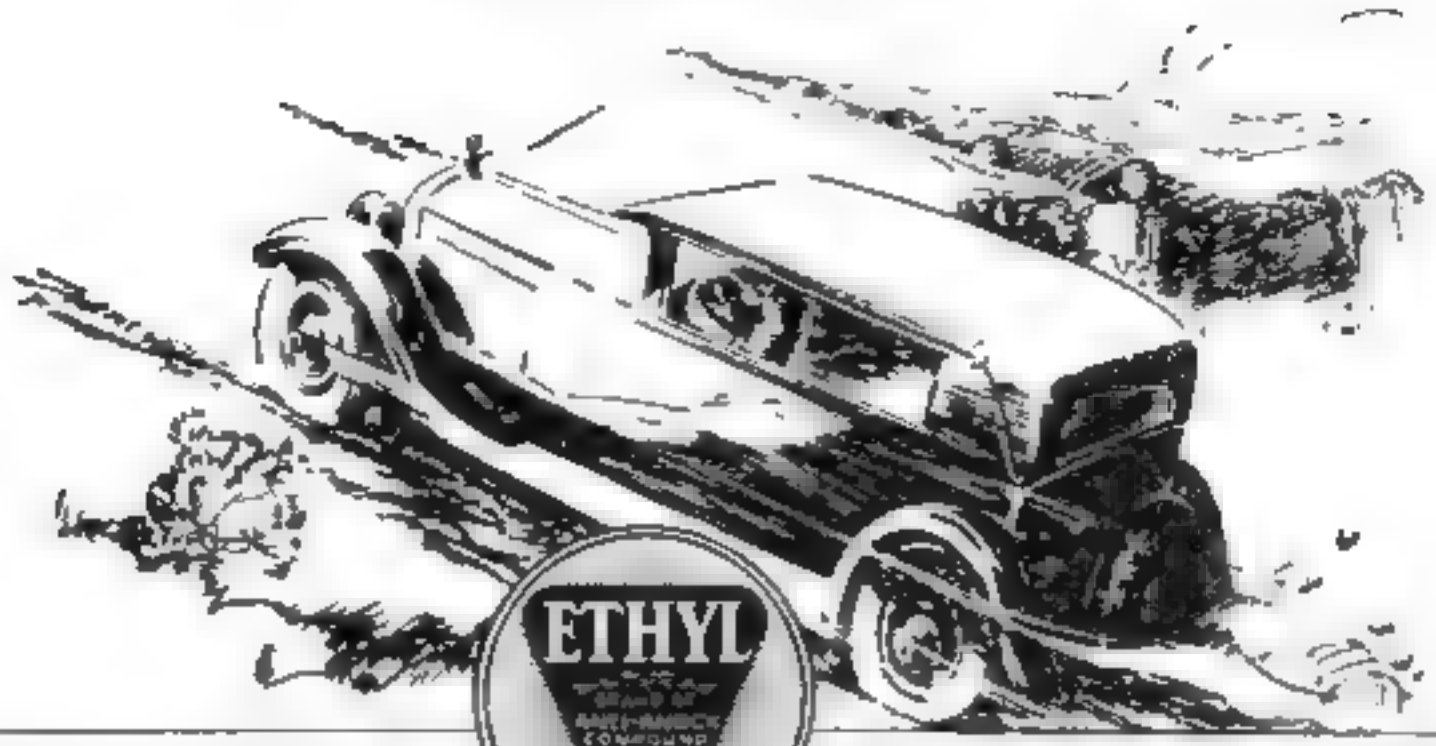
Not Dead Yet

"THE other day Glenn Frank, the noted educator, expressed the fear that modern science, while creating wonders, is killing our capacity for wonder and curiosity—in other words, making the universe all matter-of-fact.

"He never saw my kids and me reading our copy of POPULAR SCIENCE MONTHLY together. Those pictures and stories of the mysterious far-away stars, of great deeds and adventures, of giant buildings and machines, of the magic of electricity and flying machines—all make POPULAR SCIENCE a wonder book that never grows old.

"As for curiosity—well, I'm here to state that the editor of an encyclopedia would faint away if he had to answer all the questions they ask me in one sitting."

M. J. L., St. Louis, Mo.



Whatever your driving conditions

—climate—weather
—temperature—altitude

your car will run best on

ETHYL GASOLINE

There is nothing mysterious about Ethyl Gasoline. It is selected motor gasoline containing "ETHYL" fluid, the compound developed by General Motors Research to take advantage of the higher compression created by carbon deposits or by advanced engine design.

So effective is "ETHYL" fluid—a patented compound containing tetraethyl lead—that it takes less than a teaspoonful to a gallon of gasoline to give your car a performance you have never known before.

You get more power on hills and heavy roads, quicker acceleration, reduced gear-shifting and a cooler engine—*and as for high compression engines, Ethyl Gasoline made them possible!*

More than 1,000,000 car owners are now riding with Ethyl. And its price is merely the price of good gasoline plus the few extra pennies that the "ETHYL" ingredient costs.

ETHYL GASOLINE CORPORATION · 25 Broadway, New York City

ETHYL GASOLINE IS THE YARDSTICK BY WHICH OTHER GASOLINES ARE MEASURED

Signaling by smoke was a favorite method of the Indians. Messages were sent long distances by means of smoke released by a blanket held over a fire.

Distance — It is in the reception of distant stations that the superior qualities of the Grebe Synchrophase Seven are particularly evident.

It is then that the full, natural tone—which gives such enjoyment to local programs—makes it difficult to believe that you are listening to a distant station.

Easy tuning of these feeble signals, cleanly separated from strong local broadcasting and amplified to satisfactory volume, enables you to enjoy programs from far away.

Nineteen years of making only quality radio has taught Grebe how to build a set that gives *complete* satisfaction for years to come.

Grebe Synchrophase Seven, $135, Grebe Synchrophase Five, $95, Grebe Natural Speaker, $35.

Send for Booklet P. Then ask a Grebe dealer to demonstrate, in your home, that you can "get it *better* with a Grebe."

GREBE SYNCHROPHASE RADIO

A. H. Grebe & Company, Inc., 109 West 57th Street, New York City

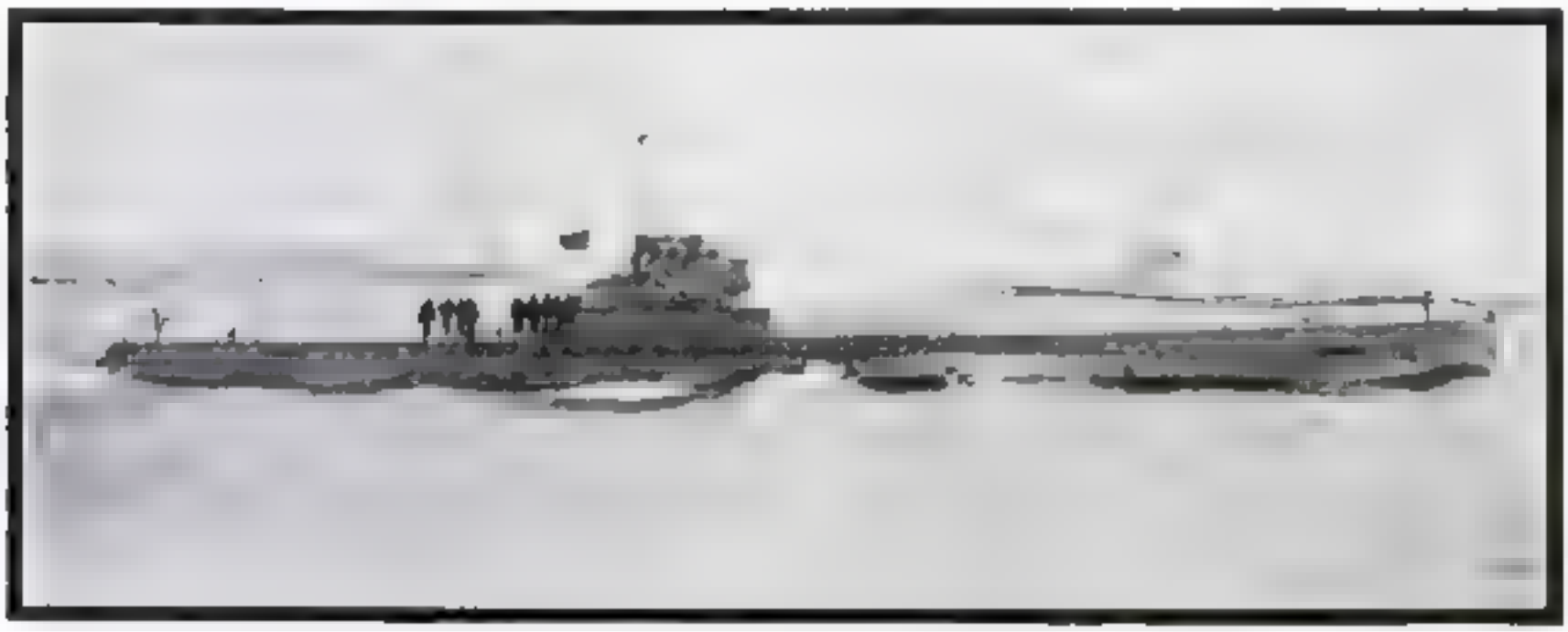
Factory, Richmond Hill, N. Y. *Western Branch*: 443 So. San Pedro Street, Los Angeles, California

Makers of quality radio since 1909

This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Popular Science MONTHLY

MARCH, 1928 SUMNER N. BLOSSOM *Editor* VOL. III, NO. 3



Making Submarines Safe

Inventions That Might Have Prevented the Tragic Loss of the Crew of the S-4 That Fought for Life at the Bottom of the Sea

By JOHN WALKER HARRINGTON

IN A gale-swept bay of the New England coast one of the greatest rescue fleets ever mobilized closed about the spot where forty men had been buried in a crushed coffin of steel, flung to the bottom of the sea.

The living tomb was the submarine *S-4*, one of the largest of Uncle Sam's undersea fighting machines, which had been rammed and sunk by the U. S. destroyer *Paulding*.

A sensitive listening instrument on the *S-4*'s sister ship, the *S-8*, caught the sound of sharp rapping on the metal hull of the stricken ship. The *S-8* answered and then the rescue ship *Falcon* with its oscillator took up communication.

The rapping spelled a message in Morse International telegraph code—a pitiful question from six of the men trapped at the bottom of the sea

"How long will you be now?"

THE question found no answer; it remains unanswered. Yet from out of the depths where those six brave men perished may yet come a response in new ways for the deliverance of sailors who in the future may face the perils of the undersea.

The *S-4* disaster off Provincetown, Mass., a few weeks ago, following as it did upon similar accidents to submarines, brought to the nation the sharp reminder that although measures to prevent such horrors had been proposed, none had been adopted. This newest catastrophe aroused the American public and its officials to give heed to that query, "How long will you be?" and to demand that the lives of submarine crews be safeguarded in days of peace.

A VESSEL of one thousand tons, the *S-4* was so near like the *S-51* which met a similar fate in 1925, that she might well be called a sister ship. She had been at the Portsmouth Navy Yard, and after slight repairs had been sent on a testing cruise before being overhauled. She was rising from a dive when the *U. S. S. Paulding*, one of the swiftest vessels in the world, came cutting the wintry sea at eighteen knots, a little more than half speed. Suddenly the helmsman of the destroyer caught sight of a slender object, the submarine's periscope emerging. A stake of fishermen's nets, he thought.

He changed his course, rang for full speed ahead, thinking only to keep the propellers of the *Paulding* from being fouled by the obstacle. Too late! The conning tower of the *S-4* lifted in sight.

Buoy marking spot where S-4 sank and sister ship, the S-8 signalling with her oscillating device to doomed crew. Above The lost vessel

The *Paulding* struck—a blow so terrific that her own bow rose high out of the water—crumpling the tower like a shell and tearing a gaping hole in the starboard side of the submarine's battery room. Almost instantly the *S-4* filled and went down by the head into the gray ooze of the Atlantic floor.

JUST what happened aboard the doomed vessel during those few desperate moments none will ever know. But from the record of code messages exchanged between the rescuers and the doomed men it is not hard to imagine the scene. A seaman in the tower, gazing through glazed portholes to report the first glimpse of green surface, is killed outright at the collapse of his sentry box. The waters, pouring through the gaping wound in the vessel's side, roar into the battery room. Brine-flooded cells of the storage batteries

send forth stifling chlorine fumes. Swirling torrents sweep into the control room—the brains of the ship just under the conning tower—overwhelming seamen at their stations before wheel and valve.

A few struggling men seek refuge in the stern or in the motor compartment, wading waist high in the flood in a vain attempt to close a bulkhead door. Six men, a lieutenant, three torpedo men and two seamen, gain the forward torpedo room, and are safe, for a time, in this steel-girt prison cell—a bubble of air twenty-three feet long, ten wide and seven high.

Central control room of the *S-4*. Among these instruments—an ironic symbol of the power of man over the forces of nature—some of the men of the submarine perished with many would-be rescuers close by

What thoughts come first to the minds of these six? Not such as a landsman might think, for these are men whose every day is a hazard. The fate of the *S-1* flashes before them. One chance in a thousand to be saved! But they are fighters all, and they will fight to the end for that chance.

Now the nerves of the *S-4* cease to throb. Her lights fade. Her heart is stilled. Heat dies away and the narrow chamber grows as cold as the water that presses against its walls. With blankets taken from the shelflike beds, the shivering men fight off the tomblike chill. Scant emergency rations are doled out. Water seeps in, covering the floor of their black prison. The air they breathe grows stale and will soon be poison, but they pin their hope on five small steel cylinders of condensed oxygen to keep life in their bodies until aid comes from they know not where. Saving their energy, they breathe as lightly as they can—and wait through hours that seem days. In their minds—for speech wastes breath—they turn over and over again the chances of coming out alive.

MEANWHILE the world above is alive with activity. The *Paulding*, having thrown a buoy to mark the place where the submarine went down, and having sent lifeboats to search—vainly—for survivors, has limped to Provincetown to report the collision. Telephone and telegraph spread the news to Washington, to the Navy yards, to the submarine base at New London, Conn. Salvage experts in New York, Boston, Norfolk, hurry by fast trains, by automobiles, even by hydroplane. Crack divers, eager volunteers, hurry to the scene.

BUT how slowly come the salvage vessels. What ages the hours have seemed to the six captives in the torpedo room, while twenty-six vessels, battered by heavy seas, can do nothing to bring them hope!

Twenty-four hours pass. A diver descends from the rescue ship *Falcon* to the broken wreck, 101 feet below the surface. He is Tom Eadie, swathed three times in wool under his waterproof diving suit. To him comes a faint sound. Is it only the echo of his own leaden tread, or does it come from the shattered hulk? Whirling a hammer, he strikes the steel shell a resounding blow. There comes back an answering rap. He telephones from his copper helmet to the *Falcon*:

"There is life aboard!"

Then the *Falcon* above, using an oscillator for communication, begins an exchange of tapping messages in Morse code—a quick tap for a dot, two taps for a dash.

"Is there any gas?"

"No," is the steady answer, "but the air is bad. How long will you be now?"

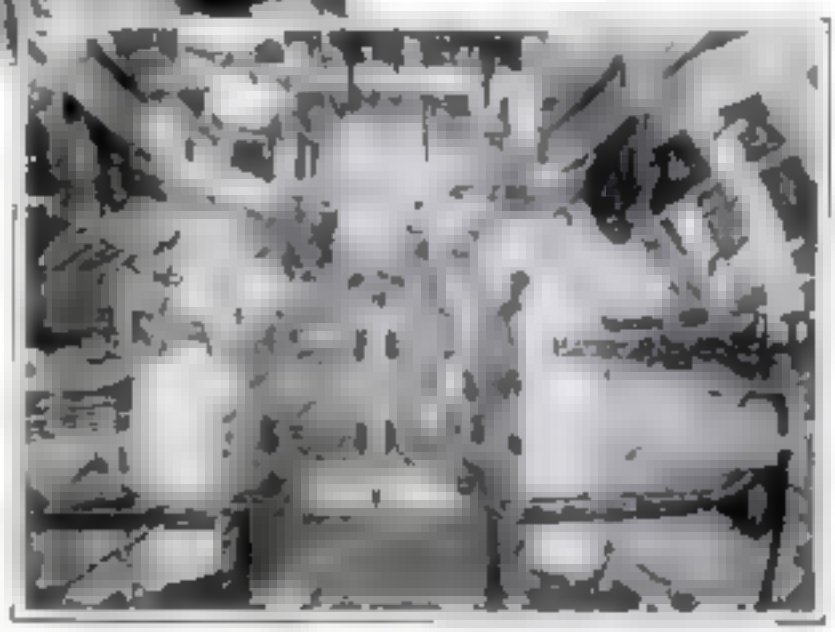
"How many are there?"

"There are six. Please hurry! Will you raise us soon?"

"Everything possible is being done," is the reply.

"Good God!" we can hear them say. "Everything possible! *Is* anything possible? Have we a chance?" They think of the *S-51*, cut down by the S. S. *City of Rome* off Block Island in 1925 and raised with her thirty-three dead nine months later. American submersibles have no outside fastenings to provide holds for lifting chains or cables. The only method possible now, as with the *S-51*, is lifting by pontoons. Divers with air guns must blow tunnels under the hulk. At this writing none had been able to do that in the silt of Provincetown, although three had nearly died in the attempt. Once tunnels are made, chains are passed through and attached to pontoons which can lift the wreck—a long and tedious process at best.

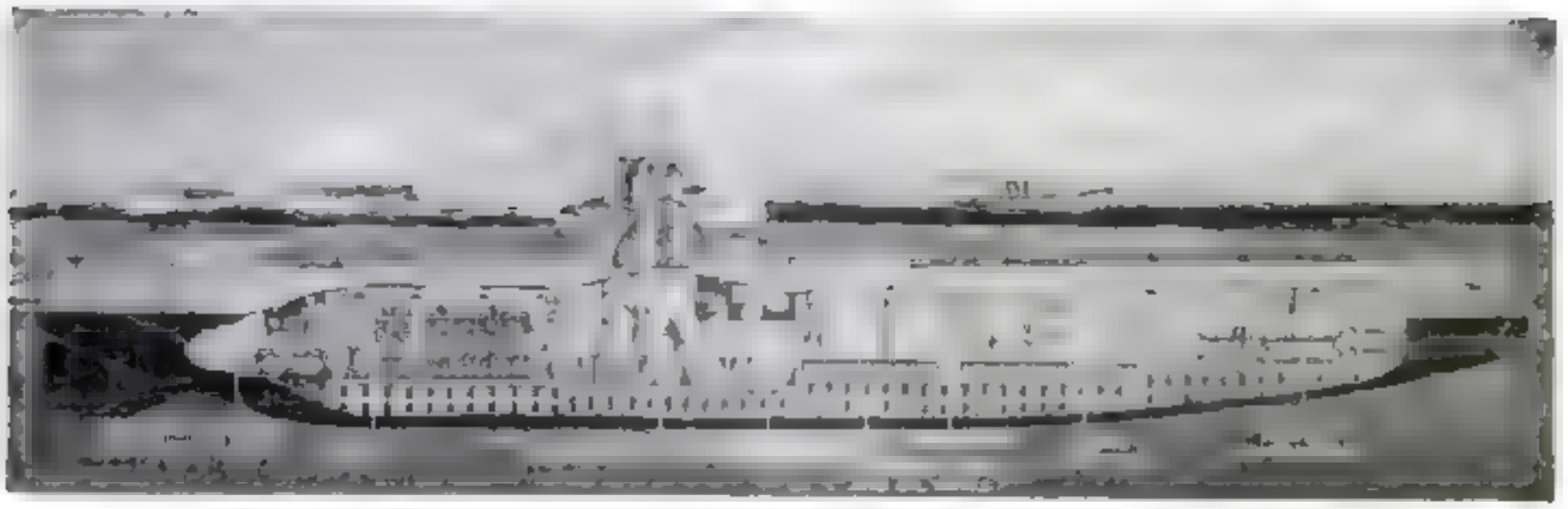
Engine room of doomed *S-4*. Here others of the submarine's officers and crew were trapped hopelessly when the crash no machinery could repair sent her to the bottom



View of aft end of the *S-4*'s torpedo room, showing the four torpedo tubes in the middle of the photograph. From these quarters six of the crew signaled for 3 days that they still lived

SCIENCE has done much to provide the means of life for the crews of sunken submarines, yet that much is far from enough. Their own resources crippled, the trapped men had only the five bottles of oxygen to keep them alive until the promise of rescue was made good. The last bottle gave out on the third day, as they tapped in one of the last piteous pleas for help. Then the tapping signals grew fainter, and finally ceased. They had perished.

The tragedy brought a flood of criticisms of the Navy Department for failing to provide better means of rescue. Even the harshest critics, however, have praised the officers and men who made every effort within their power for the doomed men. Considering the limited facilities at his disposal, it was generally conceded that Rear Admiral Frank H. Brumby in charge of the rescue fleet did his utmost. Certainly Lieutenant Commander Kilsberg, now retired from the Navy, the salvage expert who directed the raising of the *S-51* and who, volunteering his services anew, nearly lost his life in diving about the wreck, is deserving only of honor. The heroism of the divers seemed superhuman. Among those who think so is U. S. Representative Anthony J. Griffin of New York, who introduced a resolution asking for a Congressional inquiry of the whole



A longitudinal sectional drawing of the *S-4* submerged so that only the conning tower, periscope and part of the exterior rigging rises above the surface. The artist has shown all the interior, including the torpedo compartment, where life was last known to exist

subject of safety for submarine crews with special reference to the loss of the *S-4*. He moved in vain for a similar inquiry when the *S-51* was sunk.

Representative Griffin is an engineer and has invented several submarine safety appliances, which he has offered to the Government. He and others have proposed that eyelets by which the vessels may be lifted be attached to all submarines. By fastening such rings to bands welded to the hulls Mr. Griffin believes they would be entirely practicable.

Mr. Griffin also is the inventor of a life raft or chamber designed to fit into the superstructure of a submarine between the deck and the hull. In case of accident the crew could enter this chamber from below through a hatch and set it free by releasing a primer. The device, containing air cells, would be buoyant enough to rise to the surface.

Some of the newer types of submarines have air locks connected with the conning towers, from which the men can emerge when the vessel is badly injured. Under some conditions torpedo tubes may serve as emergency exits. Owing to heavy pressure of water at such a depth as that to which the *S-4* sank, the crews in such escapes would need diving helmets and protection for their chests. For such purposes light diving suits, fitted with small oxygen reservoirs and air purifying devices, are in use in the German, Dutch, Danish, Swedish and Spanish navies.

AN INGENIOUS escape compartment designed by Simon Lake, inventor of submarines, has proved practicable. Men who are about to leave the vessel first enter this room into which several atmospheres of compressed air are forced. When the proper quantity has been injected a hatch cover in the bottom can be opened and the sea water, rising only a little in the well, is kept in check by the pressure of the air, allowing escape through the hatch. Since help must be prompt, a signal buoy, which can be released from its housing on the deck of a sunken submarine and remains anchored to the distressed vessel is standard equipment in several navies. In addition, a telephone wire running from an instrument in the floating buoy to the interior of the submarine provides ready communication.

BETTER methods of connecting air lines to disabled submarine are demanded. Instead of only one inlet, leading to the interior air system of the vessel, an inlet for each compartment has been urged. Not only could fresh air be pumped in through these, but coffee and liquid foods.

The undersea tragedies of the last few years have shown that the American Navy does not own salvage vessels and pontoons large enough for speedy rescue of large submarines. In the German and Italian navies are super-salvage vessels ready to go where the government requires them. A German salvage ship, the *Vulcan*, which raised the *U-1* at Kiel in 1911, can lift the largest types of submarines with ease. She consists of two hulls, which are really huge pontoons that can be lowered or raised by admitting or releasing water ballast, as does a submersible. The sections are joined together by a heavy steel bridge on which powerful cranes are mounted.

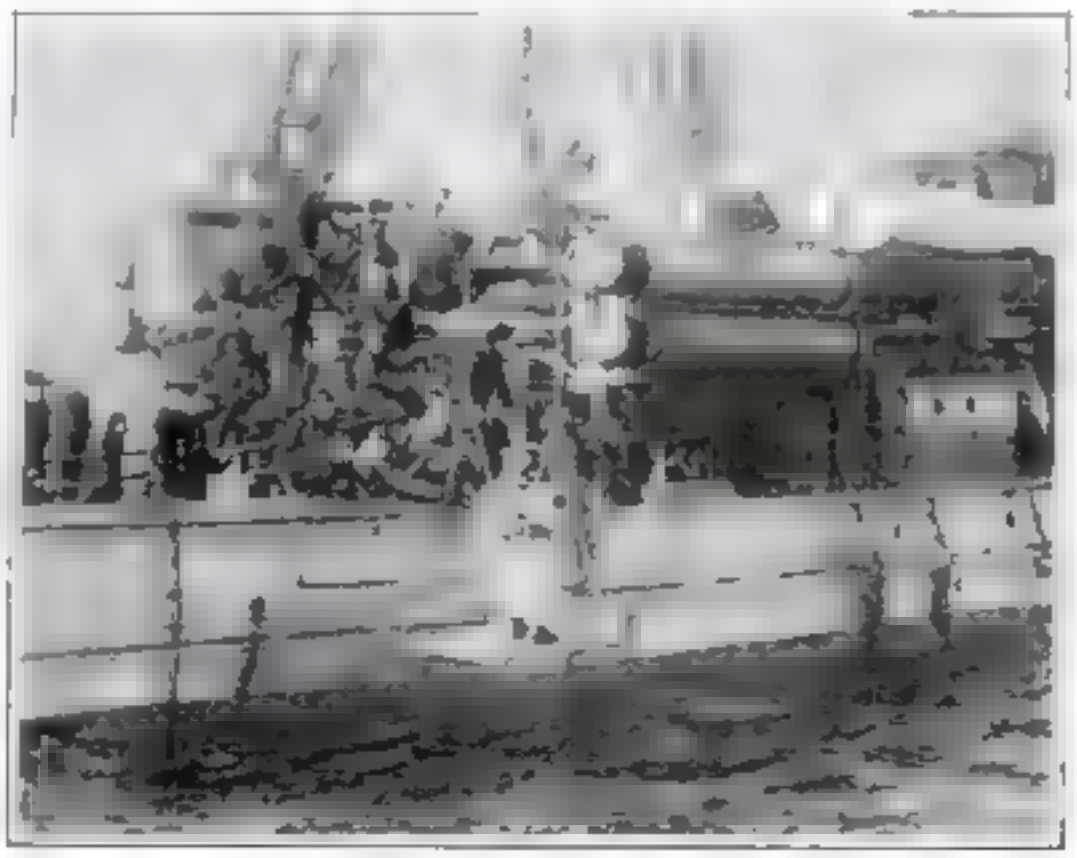
IT IS estimated that effective salvage vessels of this type could be built in the United States for $1,500,000 each. Even at a higher figure, their use would seem to be justified, for large submarines cost about $3,000,000 apiece, and carry gallant men.

Representative Griffin has suggested that many of the Shipping Board vessels, now moored in out-of-way places, might well be converted into salvage outfits similar to the *Falcon* by joining two of them catamaran fashion. Adequate equipment of all kinds should be built and ready to respond when the need arises, not made "to order."

HOW little prepared the Government has been for such disasters was illustrated in the now almost forgotten loss of the submarine *F-4* near Honolulu. Since no salvage vessel was available, one was made up from two scows and a crane, requiring three weeks labor. Then it failed. So expert divers were summoned from the Brooklyn Navy Yard, 5800 miles away, and pontoons were built in San Francisco and shipped on a cruiser. The *F-4* was raised at last—with the bodies of its crew of twenty-one.

Definite action toward greater safety now seems pretty well assured. In addition to the formal Navy Board of Inquiry, and a Congressional investigation into the *S-4* disaster, Secretary of the Navy Wilbur has announced he will ask a commission composed of both naval officers and civilians to study the situation.

Possibly never before have the American people become so aroused over a naval disaster. If the lesson serves to safeguard the lives of middies of the undersea in the future, the gallant crew of the *S-4* will not have perished in vain.



Diver Wickwire, being lowered from the rescue ship *Falcon* in one of the efforts to pierce the shell of the *S-4* in such a way as to carry life-saving air to her valiant crew without admitting at the same time water that would instantly cause their deaths

Col. P. H. Fawcett, of whose party nothing has been heard since he and his son and a friend entered Brazilian jungle three years ago

Is Lost Explorer Now Jungle God?

By FRANCIS GOW SMITH

"CUYABA, Brazil. Freed from romantic captivity as the living idol of a remote Indian tribe hitherto unknown to science, Col. P. H. Fawcett, the noted British explorer who in 1925 vanished into the jungles of Matto Grosso, is now being brought out to civilization.

"Messages from Commander Dyott, leader of the Fawcett relief expedition, indicate the rescue was accomplished by a clever raid upon the savages' village in which airplane and overland party cooperated."

WITHIN the next eighteen months I expect to read a news despatch worded much as above. It will mark the climax of an adventure rivaling the most sensational exploring feat of the last half century.

In 1871, the world waited breathless while Henry M. Stanley fought his way hundreds of miles through equatorial Africa to rescue the long lost Scottish missionary, Dr. David Livingstone. Today, Commander George M. Dyott, explorer and lecturer, has set forth on an even more daring mission to wring from the jungles of Brazil some clue to the mysterious fate of the vanished British war veteran, Lieut. Col. P. H. Fawcett, D.S.O.

After a life dedicated chiefly to South American exploration—as Livingstone's was dedicated to discoveries in Africa—Col. Fawcett undertook, three years ago, to survey and map the least-known fastnesses of Matto Grosso. At the age of fifty-eight, accompanied only by his son Jack and one other white companion, he plunged northward from Cuyaba into the wilderness—and he has not been heard of since except through romantic rumors that only increase the mystery of his disappearance.

COMMANDER DYOTT is a fellow Englishman who has already made two spectacular trips through the heart of South America—one over the Andes from the Pacific and down the Amazon, the other last year along Roosevelt's trail and down the River of Doubt. But this time Commander Dyott, financed as Stanley was by American capital, must penetrate a gloomy wilderness more forbidding than he has formerly traversed, and even less known than Africa was when it swallowed up Livingstone; and Dyott in Brazil will have no such clues as helped Stanley on his historic quest.

The name of Henry M. Stanley fifty years ago was a synonym for daring adventure. After exploits on both sides in the Civil War, he was commissioned by James Gordon Bennett of the *New York Herald* to find Dr. Livingstone, who in 1865 had set out to discover the long-sought sources of the Nile and for nearly seven years had not been heard of.

Stanley, leading 200 men inland from Zanzibar through the densest of African jungles, soon began to get word from the natives of a strange, bearded white man lying ill and helpless at the slave-trading town of Ujiji, on Lake Tanganyika. And there, on November 10, 1871, Stanley, exhausted by his eight months of hardship, had no words to greet the venerable missionary but these, "Dr. Livingstone, I presume?" which still echo in the pages of history.

But Commander Dyott is faced by the apparently insurmountable task of locating three solitary exiles somewhere in 350,000 square miles of trackless jungle—which Col. Fawcett called the last great blind spot on the habitable globe. It is greater in extent than the combined states of Ohio, Illinois, Indiana, Iowa, Missouri and Michigan. Native frontiersmen fear to cross its fringes, beyond which roam perhaps half a million naked Indians, some of whom have never outgrown the stone age.

IT IS true that Col. Fawcett has been for years at home in just such country. A British artillery officer who served during his youth in Ceylon, Malta, China and Morocco, he was lent by his government in 1906 to Bolivia to act as boundary commissioner. Having helped clear up the disputed line between Bolivia and Peru, he gave himself up to Brazilian

Francis Gow Smith near River of Death, Borora. Above, Indians near Tapirapoanh, savages of the type Col. Fawcett believed he might able to get on with in entire safety. Right, Borora Indians, type of the tribesmen Col. Fawcett must have encountered traversing the wild and forbidding region of the River of Death

FAMOUS authority on Brazil offers here an amazing explanation of the mysterious disappearance of Col. Fawcett, British adventurer, who is now being sought by rescuers in the South American wilderness

Where Fawcett and his party vanished. His possible adventures are pictured in the accompanying article by an expert who has penetrated the wilderness

Commander George M. Dyott, himself an experienced explorer of Brazil, who is setting out into the wilderness to find his lost fellow explorer and compatriot, Col. P. H. Fawcett

exploration until the World War, in which he brilliantly commanded a brigade of field artillery.

In 1925, backed by American newspapers and the British Royal Geographical Society, he plunged on his present venture with only his son Jack and one friend, Raleigh Rimmell, to accompany him.

BESIDES mapping unknown territories in the neighborhood of the Paranatinga and Tapajos Rivers, his plan was to seek the remains of an ancient civilization, antedating Egypt's. But Brazilians in Matto Grosso who were among the last to discuss his plans with him tell me and I believe that the Colonel's real intention was to discover the fabulously rich lost Gold Mine of the Martyrs, unworked for two centuries since its early Portuguese discoverers were murdered by their Indian slaves—which is supposed to be somewhere north of the River of Death, between the Xingu and the Araguaya.

NOW in the late spring of 1925 Colonel Fawcett sent back by messenger his last report, and it showed him veering toward that region. In a month's arduous travel northward from Cuyaba, he had reached the domain of the Bakairi Indians. His two native *camaradas*, dreading the savages ahead, were about to leave him. Raleigh Rimmell was infected from an insect sting and the pack train of fourteen unruly animals was causing infinite trouble.

Since then, nearly three years of utter silence. And as Commander Dyott sets out, the question arises whether Col. Fawcett is still alive.

A French engineer, Roger Courteville, was reported to have found Fawcett living as a hermit in a "jungle paradise" a hundred miles from Cuyaba, but this report has been thoroughly discredited. Another English explorer, Captain Alfred Henry Morris, later visited the same territory hunting Fawcett, and found not a trace of him.

FROM my own practical experience in the region I have reached certain conclusions as to his fate.

I believe Col. Fawcett is still alive, and when I say that he is today probably the captive tribal divinity of a band of savages. I am supported not only by my own experiences but by historical and ethnological data and by the opinions of Brazilian frontiersmen with whom I talked less than a year ago.

Mrs. Fawcett, the Colonel's wife, who has been living at St. Malo, France, says telepathic messages from him convince her he is alive and she has said:

"I believe my husband is the prisoner of some tribe of Indians who are treating him well because of their superstitious awe of his powers. Curiously, Commander Dyott's own experiences have been similar. He was once missing for months—all that time being kept prisoner by Indians. Col. Fawcett will yet be found."

From Col. Fawcett's last letters the Royal Geographical Society's experts deduce that the explorer had altered his originally announced plans and, having reached the Rio São Manoel, tributary of the Tapajos, was swinging northeastward. It seems certain that he had hit on the plan of traveling overland, south of the tenth parallel, along a route that would have brought him to the Araguaya River. And this route would take him directly through the traditional region of the Martyrs' Gold Mine.

NOW had Colonel Fawcett continued northward toward the Amazon between the Xingu and Tapajos Rivers, he would have run into the hands of the Mundurucus, who are ind ustrious headhunters. Or, had he sought to avoid them by descending

(Continued on page 1—)

Left: Semicivilized Indians northwest of Cuyaba, more hostile than the uncivilized ones of the interior. Above: Indians near Rio Tapajos showing a pantomime by which they killed members of a government topographical commission. Afterward their arms were taken away. Right: A Bororo behind a tree, luring a bird by imitating its cry to kill it

"A climbing fool!" Cheese shouted from where he was squatting beside Jack and the girl. "She's what I call a rocket, and nothing else but

All Metal

By ANDREW A. CAFFREY

What Happened When the Big Air Liner Took Its First Trip A Story of Ingenuity, Parachutes and a Girl

JUST mention all metal aircraft construction and you are sure to start some sort of argument. But ask for the best all metal pilot in the game and the flying world points her out—Jack Page. This varn has to do with an all metal combination, Jack and his all metal airliner the *Pacific Gull*.

The three-engined ten-passenger flying cruiser the *Pacific Gull* was the first multi motored seaplane to attempt seriously to ply the air as a common carrier between Los Angeles and San Francisco. But the *Pacific Gull's* career was brief, epic and brave. Like so many other pioneering tries, the log of the *Gull* goes unsung, and unremembered save by a possible ten. The ten passengers and two others—Pilot Jack Page and his worthy flying mechanic, "Cheese" Farling.

Pilot Jack Page was the owner, designer and builder of the great craft, which was Jack's oldest and best dream come true. More than a year's hard work had gone into the construction. Jack, Cheese and half a dozen others had done the sweating. How Jack promoted the cash—she cost upward of sixty thousand dollars—no one knows. But, from here and there, the money came; and the plane had taken shape. Great shape, too.

Every truss that went into the *Gull* was hand-picked and tested by Jack. Every yard of dural was the best. All fittings were hand-sawed from cold-rolled stock, amply reinforced and A-1 pieces of workmanship. Jack Page squeezed the old brain dry trying to make things right. That was Jack every time. air-sized and air wise in the exacting things of airways. He was big in every way possible, big in the hoots from which he towered, and big in his handling of a tough game—air.

So he gave something worthy to the air when he trundled the *Pacific Gull* out for its first hop. And the aeronautical world realized that Jack and coworkers had sounded a new note in aviation. The job was good.

The big craft was of orthodox biplane design. It had a wing spread of eighty-five feet, the top of the upper plane was about two stories aloft, and its overall length would make the average big plane appear stubbed. The ten-place, glassed-in cabin was luxuriously appointed and entirely protected the voyagers from any contact with the elements. Behind and above, side by side and in the open, were the pilot's and flying mechanic's seats. For psychological effect, Jack Page had arranged this cockpit's segregation if the passengers were unable to watch the pilot, in the event of anxious moments, they—the passengers—would never guess that anything was amiss. A steplown and short gangway connected this seat control pit with the main saloon.

Each of the ten seats of this fuselage cabin was boothlike, pretty much after the design of a Ferris wheel's caged cars. To become seated, the passenger stepped down from a narrow cat walk which centered the compartment. The brief dropoff made one feel that the legs were hanging through the floor, and maybe they were. When in the seat, the side cushions came just about shoulder-high. Comfortable, that's what it was.

This new seating idea was one of many other important innovations. But Jack Page, always short on talk, allowed them to go unmentioned. And it was these unmentioned things, surprise parts—that, as was noted before, the ten passengers will never forget. No, never! Yet—and make note—Page never "lost" a fare.

THE powering of the great *Pacific Gull* was unique in that two types of motors were used. On each lower wing, at the first interplane struts, was a power nacelle hiding a cowled-in Wright engine of one hundred and eighty horsepower. These two motors were worked as "pushers," that is, with the propeller behind the trailing-edge of the wing. The third power unit, the central motor in the nose of the fuselage, was a Liberty "12" of four hundred and fifty horsepower. In all, the *Gull* had upward of eight hundred measures of that much-desired stuff—horsepower.

The big Liberty engine was solidly bedded on a four-pronged tubular carrier that was firmly bolted—each of the four prongs with a large drift pin—to the fire-shield bulkhead which was the nose of the fuselage. It was a fine mounting. Simply remove two drift wires and drive back four pins and, hooking a block and tackle to the whole works, out came the heavy power unit motor, water radiator, oil tanks and all. From a point of efficient field service you couldn't beat it, and Jack Page, saying

little about the installation, took great silent pride in this piece of clean-cut engineering. The mention of this motor mount is important!

On the morning of the *Pacific Gull's* first scheduled Los Angeles-San Francisco flight, the first passenger to arrive was plural. It was a man and wife wherein the man was irrelevant. And, at first, you didn't see him; but, on second thought, you knew that all those hand bags weren't carrying themselves.

"Where do we sit?" the lady demanded, and waved two good one-way tickets.

Cheese Farling—he was doing the seating—waited till he got a good look at the man before making answer. "About ninety pounds wringing wet," Cheese speculated under his breath. "And she," he thought, "does not weigh much more. . . .

"IN THE two rear seats, madam," Cheese said.

"But the front seats," said the lady, "they're empty; why can't we have them?"

Cheese was just about to pull that old gag, to wit: that both ends of the plane arrive at the same time. But Jack Page, knowing how to handle women, came to the front and explained that a ship must be loaded in such a way as to best favor its longitudinal balance, and insofar as the plane's center of gravity always falls somewhere in the wing bay, there too should the craft's load be carried. In the matter of passenger loading—stubs and thins to the rear; fats and oversized to the front. The lady understood perfectly.

"But my brothers," she said, "where are they?"

"Now there's a hot one!" Cheese exclaimed, inwardly, as he listened. "Where are her brothers?"

"What do you mean, madam?" Jack asked. "Did you expect your brothers to see you off?"

"NO, NO, NO! My brothers are going, too. They bought their tickets when I got ours."

"There's half an hour yet," Jack informed the agitated one, "and no doubt they'll be on the next bus."

"You'll seat them next to us?"

"Yes, madam."

"When do we depart? When will we be in San Francisco? How far is it to Frisco? How long does it take to get there? Will we be there before the steamship *Hilo* arrives from the Islands? Will we? We must. My sister and her family are on the *Hilo*."

"When is the *Hilo* due?" Jack inquired.

"This afternoon," the lady told him. "According to the company's Los Angeles office, the *Hilo* was two hundred miles off shore at six o'clock this morning. . . . Will you promise to get me to the *Hilo*? We must be there when she docks, to meet my sister."

"I'll get you to the *Hilo*," Jack Page promised in perfectly good faith.

Just as this conversation terminated, the two brothers arrived and lined up with the luggage-carrying husband. Cheese stowed all hand baggage in the tail-bay compartment, and marched the three boys into the plane.

The next four passengers came in a body; all men, on duty bent. They were government agents of the Bureau of Agriculture.

"When do we get into Frisco?" the chief asked.

The plane circled down over the *Tokio*. Already the big liner had sighted the five parachutes and —judging by the white foam along her sides—had reversed her screws and was standing by

"Take off at eleven," Jack said, "and arrive at three, four hours all told."

"If you make it by three," said the chief, "that will be jake! We've got to be there when the *Tokio Maru* makes port. She's loaded with silk, you know, and we've got a big job ahead of us—a new silk bug has been coming in from the Orient. Another plant pest. The *Tokio Maru* was three hundred miles off shore early this morning, or late last night. She's fast. You're sure we'll get her before quarantine?"

"Easy!" Jack cheered.

MORE luggage was packed away in the box behind the pilot's cockpit and the four government men took their seats.

Then the last two voyagers stepped from a taxi, came through the ropes, and dropped their bags at Cheese's feet. These two, a large man and a small girl—small but oh, boy!—were openly excited.

"Just got under the wire, eh, Sis?" the big man grinned as he dug up his tickets.

"Bet we did, Dad," the girl answered. "And if we missed

thus, we'd miss the *Tokio*." See—two more running for the *Tokio*.

When do we make Frisco?" the father asked as Jack forced him through the small door. "You've got to get us there before the *Tokio Maru* shoves her nose up against *The Embarcadero*. . . . This little girl's ma and sister are on that Jap boat and they don't expect us. And if you don't get us to them—well, boy, your insurance is the best thing you ever did."

"I'll put you right down on her nose," Jack laughed. "You and the young lady will sit up front."

"With the pilot?" the girl exclaimed and enthused.

"NO," JACK smiled. "On this plane, the pilot rides the tail."

"But I've always wanted to ride with the engineer," the girl replied. And, presently, she was moving in the direction of desire. When the American girl wills, she will!

"Sure," the fat old boy said as Cheese and Jack showed him to his tight-fitting seat, "let Sis ride with the pilot on the tail." Cheese busily readjusted the safety belt which fell several inches short of circumnavigating the fat one's equator—"What do I want this belly-band for anyway?" the big man finally asked. "Boys, you're not going to loop this flying hangar, are you?"

"Just an ordinary precaution, Mr. Deuss,"—Jack had quickly rubbed the name from the tickets which he still held, and, also, noted that the girl's name was Almira Deuss.

"Are all these people trussed up too?" Mr. Deuss asked and laughingly looked about. He discovered that they were. "O.K., boys, tie me tight! And how about it—can Sis ride the tail?"

"It's jake with me," Cheese agreed. "I don't need a seat." Almira—Cheese knew—was not the kind to be in anybody's way.

"It's settled, Mr. Deuss," Jack consented. "I'll show your daughter how it's done." Jack didn't mind if she was in the way.

"Thanks," Mr. Deuss smiled. "But you flatter yourself, boy. Before you're in the air five minutes, she'll be showing you how it *should* be done! Then we *still* need these here form-fitting girdles."

From passenger to passenger, working aft, Jack and Cheese moved and inspected their safety belts. Also they made certain that the aisle door of each small booth was firmly closed. Then they were ready to shove off and Jack moved back and up to his controls. Cheese went overside to assist the ground crew with the starting of the motors.

ONE by one, the side motors barked into action, then settled down to their warming-up purr; and with a bang, the Libertys came to life, howled for a moment, then fell to "cutting 'em off" as only a well-behaved Liberty can do. A cloud of dust paraded back to the rear, the crowd of spectators gave way, and the *Pacific Gull* was a throbbing thing of splendid life.

While the motors warmed, Jack called Cheese to the cockpit and pointed to his instrument-board compass.

"Look at it!" Jack exclaimed. "The darned thing is sure gyrating like a merry-go-round, eh?"

Cheese watched the dancing compass float. "She's sure haywire, but what can you do?"

"Not a thing," Jack resigned. "But it gets my goat! One minute your compass is in perfect orientation, and the next minute the motor generators have turned it into a pinwheel. . . . Hold onto everything, I'm going to give these motors a run."

For thirty seconds the three motors, at top speed, made the world awful with their combined roar, then, slowly, Jack closed the throttles and the power units fell to a muffled silence once more.

"Pull the blocks!" Cheese yelled, and climbed aboard. The ground crew removed the wheel chocks, warned back the crowd, the motors sent up their wail again, and the *Pacific Gull* lifted its tail and was gone.

Getting off the ground, Pilot Jack "poked" his ship's nose at Hollywood and the hills beyond, to the north. The craft made altitude easily.

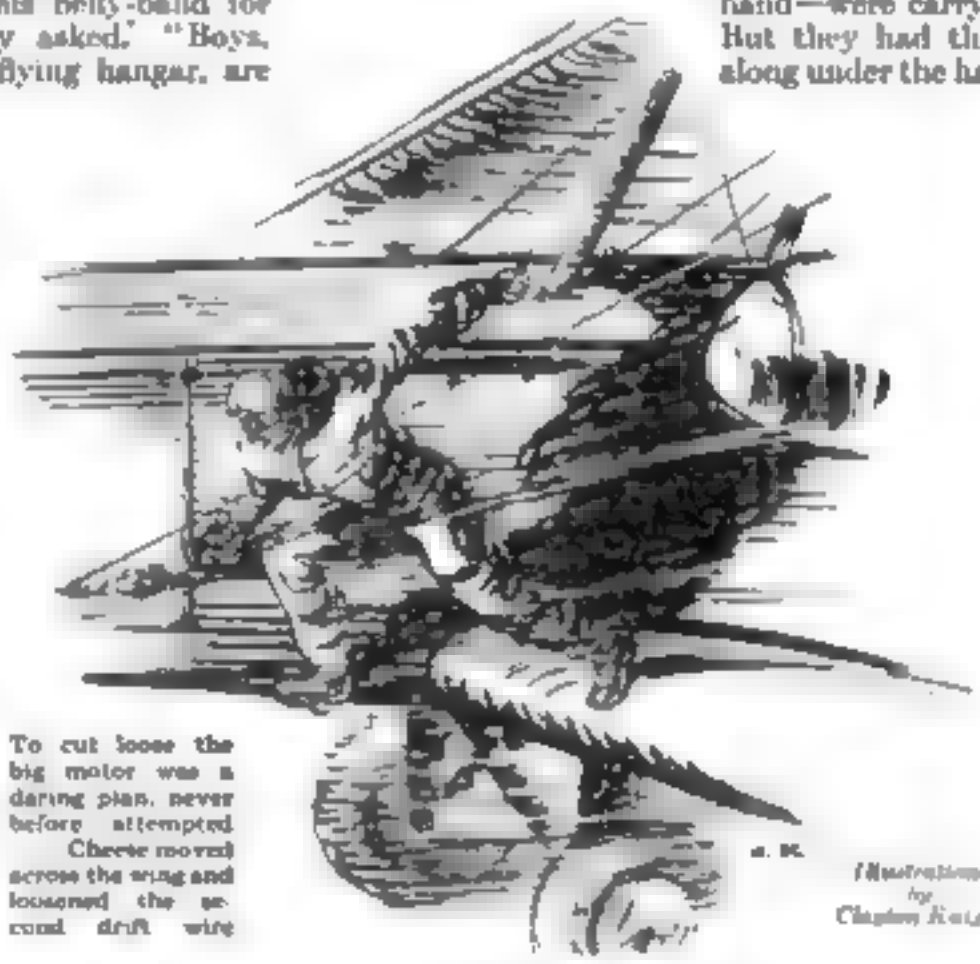
"A climbing fool!" Cheese shouted from where he was squatting beside Jack and the girl. "She's what I call a rocket, and nothing else but!"

"It looks like heavy going ahead for the rocket," Jack answered and pointed to cloud banks far afront. "Pray a little, Cheese."

The *Pacific Gull* was in clouds before she had lost sight of Hollywood. And those clouds were getting heavier every minute. They seemed to be heaviest inland, so Jack eased off toward the sea.

"I'll have to work along the coast," Jack yelled. "We'll cut over Santa Barbara and keep just west of the ridge."

The coast was picked up a little south of Ventura, but the clouds were heavy as ever. Visibility over the Pacific was very poor, and the mountains—now all at their right hand—were carrying the black sky on their tops. But they had the water below and could sneak along under the hard going, and, for the time being, things were not too bad. Not too bad, but bad enough. The *Pacific Gull's* first hop wasn't going to be all joy. And Jack Page was holding that slap "in his lap" and silently cussing one bad mountain pass that he was going to need, and need badly.



To cut loose the big motor was a daring plan, never before attempted. Cheese moved across the wing and loosened the second drift wire

Illustrations by Clayton Knight

BEYOND Santa Barbara a pall of black drapery fell over the *Gull* and sent out shapeless arms of sinister omen. Beyond right over her nose, the sea fog curled up, and in that gray-green mess three propellers cut their whirling disks of white. Below, the sea had also gone out. And Jack Page drew the big ship a little closer to him.

Now, with all earthly marks gone, Jack flew entirely by altimeter and instinct. He held an altitude of three hundred feet, tried to visualize the lay of the shore, at his right and ever and ever gave way to the left. He knew that the open sea was better than mountains. Anyway, this fog could not last long. Rain was falling now, perhaps she'd clear.

But the thick going did last. One hour payed out, and another. By that time, the *Pacific Gull* was in a mad plight. Jack Page—without the aid of a compass—was lost. But, when lost—you fight!

The cabin passengers also realized that all was not well. At first, Cheese had tried to tell the back-seat four that the cloud effect was only smoke from burning rubbish, but he couldn't make it stick. Mr. Deuss and the four government men nervously tapped the arm rests of their snug booths and stared out the side windows.

"Everything will be jake," Cheese told them. "We've got gasoline enough for three hours more. Long before the end of that time, we'll ride out of this stuff." This was a reasonable hope.

"Yes, but where?" Jack asked himself as he listened to Cheese's voice come up the companionway. "You afraid?" he asked the girl.

"Do I look it?" she smiled back.

"No." As he spoke, Jack studied her face. And knew.

"Well, that's the correct answer, Jack Page. Lead on."

THE Pacific Coast, from Los Angeles through Santa Barbara to Point Pedernales, runs nearly due west for one hundred and fifty miles. But at that point—Point Pedernales—the mainland quits its westward push and the shoreline points almost straight north to San Francisco, two hundred and sixty miles away. So, at the end of his second (Continued on page 150)

Why We Are Immune to Some Diseases

How Tiny Bodies in the Blood Protect Some Men Against Illnesses That Others Cannot Survive

By
LIDDA KAY

FOUR men of Buffalo, returning some years ago from a convention in a neighboring city, were stricken with typhoid. The infection was traced to the water they had drunk in the convention city.

Why was a fifth Buffalo man who drank the same water apparently immune to the onslaughts of the typhoid bacteria? And why had all but a few residents of the convention city been able to drink the poison-laden water with impunity for weeks, possibly months?

In the answers lie the results of some of the most important discoveries in the history of medicine, as well as of a series of amazing experiments dating from Pasteur's inoculation of hens with old cholera germs. They go far toward explaining why we contract the diseases we do, as well as those instances of apparently miraculous escape.

Two men using a public telephone receive diphtheria germs deposited there by a previous patron. One develops the disease, the other doesn't. Three children in a family come down with measles, the fourth is immune.

Such instances can be multiplied indefinitely. The phenomena of natural immunity have been observed for centuries. Yet only recently—since the establishment of the bacterial origin of disease—have any workable explanations been offered. The discovery of ways to make us artificially immune was the next step. Some day the doctors tell us, they will have found vaccines and serums to immunize us all to all diseases of bacterial origin. The family doctor of the future will be an immunologist.

Their theory is this:

In our bodies are countless armies of tiny chemical substances called antibodies—our chief front-line fighting force against disease. Each antibody has its own particular antigen, or substance for which it has a chemical affinity. Any disease germ is an antigen for a certain antibody, and if each invading germ finds its particular antibody in our bodies a battle ensues, the antibody destroys the germ, and we ourselves do not even know that we have won a victory.

Your body may at this moment be well fortified with diphtheria antibodies, have a goodly store against typhoid. Consequently the diphtheria germs are not even noticed when they gain a foothold and you are exposed to diphtheria. Your hope against typhoid would depend upon the speed with which, once you were exposed, your body *created* enough antibodies to destroy the typhoid bacteria.

The Buffalo man who escaped had natural typhoid antibodies. Residents of the affected city had apparently been able to develop immunity through the growth of antibodies in their blood on a city-wide scale, the water pollution being probably a very gradual process.

For centuries, of course, men had profited over two kinds of immunity—natural or innate, the other acquired after one had survived a particular disease. Cholera, for example, conferred immunity for life on him who survived. Curious preventive measures followed these observations. Asiatics made children wear shirts of sufferers from the light form of smallpox, reasoning that the children would also acquire the disease in light form and thereafter be immune from a possibly fatal attack. The Turks, on the same theory, inoculated themselves with pus from mild cases of smallpox.

Then, one day in 1880, Pasteur by accident inoculated several hens with old cholera germs. With a culture made a few weeks before, instead of the usual fresh one, he hoped to kill all the chickens. And they were henceforth immune.

That was the beginning of laboratory made vaccines. Pasteur had shown, in effect, that when weakened bacteria are injected into our bodies, they work no serious harm but cause creation of anti-

Above: Boston school children ready to receive the Schick test for diphtheria. If slight injection of the disease toxin causes inflammation, one is susceptible. Middle: A child receiving injection for test. Below: Preparing diphtheria toxin to test immunity. Scarlet fever and smallpox toxins also are made to test immunity against these diseases

How disease antitoxins are prepared. A slight injection of a disease toxin, as above, causes the development of antibodies in the blood of a horse

Blood of the inoculated horse is later drawn painlessly, and the serum is extracted and administered to human beings, either to confer immunity against illness or as a treatment

odies which protect us against virulent bacteria of the same species. The immunity so conferred is called *active immunity*, because our own bodies create the protecting antibodies.

A few years later other scientists discovered that the blood of immunized animals, transferred to other animals, conferred temporary immunity to the same disease. That was the beginning of serum prevention and treatment of disease. The immunity thus conferred is called *passive*, because the antibodies contained in such blood or serum are transferred *ready made* into our bodies.

BRAVE men have risked their lives and many have died, these last forty years, in the search for new vaccines and new serums—for always some human being had to be the first on whom the new preventive was tried. When Jack Kibler, a private in the Army, was honorably discharged from the service recently, it was revealed that Kibler, with a few other American soldiers in the Philippines, submitted voluntarily to inoculation with the germs of dengue fever. Doctors studied the progress of the disease among the patients, with a result that the fever rate among American troops was reduced from eighty per thousand to twenty.

When a squad of American Army enlisted men who had volunteered to risk their lives in a similar way were told that provision had been made to compensate them, they joined in refusing to go on if they were to be paid. In one of the most dramatic military scenes away from a battlefield the high officer to whom they gave their ultimatum rose and bowed and lifted his hand.

"Gentlemen," he said, "I salute you."

You will be glad to know they survived.

Recently a Philadelphia doctor announced a serum treatment for rheumatism, which is not due to old age, but is as much an infection as measles. The importance of the announcement lies in the fact that heart disease causes more deaths than any other malady; and rheumatism, according to Dr. Henry Albert, commissioner of health of Iowa, causes from fifteen to twenty-five percent of heart disease.

MORE lately two Denver physicians, Roy P. Forbes and Berryman Green, demonstrated that a child with measles can, by giving a few drops of his immune blood, protect his younger brothers and sisters from the disease. When the patient's fever begins to decline the blood is taken. Serum made from it produces a very mild form of modified measles in the children who have been exposed to the disease, and so confers immunity without making them ill.

Today man can make himself immune, by vaccines or serums, to typhoid, smallpox, rabies, diphtheria (temporarily or permanently, depending on whether antitoxin or toxin-antitoxin treatment is used), dysentery, plague, cholera, lockjaw (temporarily), scarlet fever and measles (temporarily).

INFLUENZA, infantile paralysis, pneumonia and tuberculosis are diseases against which immunization is still being sought by laboratory workers.

Yet we have only just begun to combat infections. We treat symptoms instead of treating root causes and effects. Frankly, we are ignorant to a large degree of the chemical constitution of living matter.

If the time and energy and ability that have been spent on metallurgy were spent on medicine we could manufacture antitoxin as readily as we can make cobalt steel. There lies a great field for the chemist who will turn his attention from dyes to biochemistry.

With the accumulation of new data on immunity, other questions rose. Are immunity and susceptibility hereditary? If no member of your family ever had the measles, can you assume that your children are safe?

"No, you can't inherit permanent immunity to infectious diseases," one doctor puts it, "any more than you can inherit susceptibility. Children acquire tuberculosis and other infectious diseases from parents only as a result of close contact with them. The same goes for immunity."

Dr. L. W. Famulener, well-known immunologist of New York City, told me that city people develop a markedly greater degree of immunity and resistance to diseases than their apparently healthier country cousins.

"The explanation," he said, "is that constant exposure to disease germs in cities over a period of years stimulates the gradual production of antibodies. You know that the injection of gradually increasing doses of diphtheria toxin into a horse will eventually make him immune to a dose that would ordinarily prove fatal. Much the same process of immunization is constantly happening to city dwellers. You get a few pneumonia germs, say just enough to stimulate the production of a few antibodies in your body. A few weeks later, you get a slightly increased dose and build up still more antibodies. Eventually in this way you may build up complete immunization to the disease.

"NOT being constantly exposed to infection in crowded streets and places, the tissues of country people do not have to build up the antibody protection.

"Similarly, the children of certain private schools in New Jersey showed a far greater susceptibility to diphtheria than public school children."

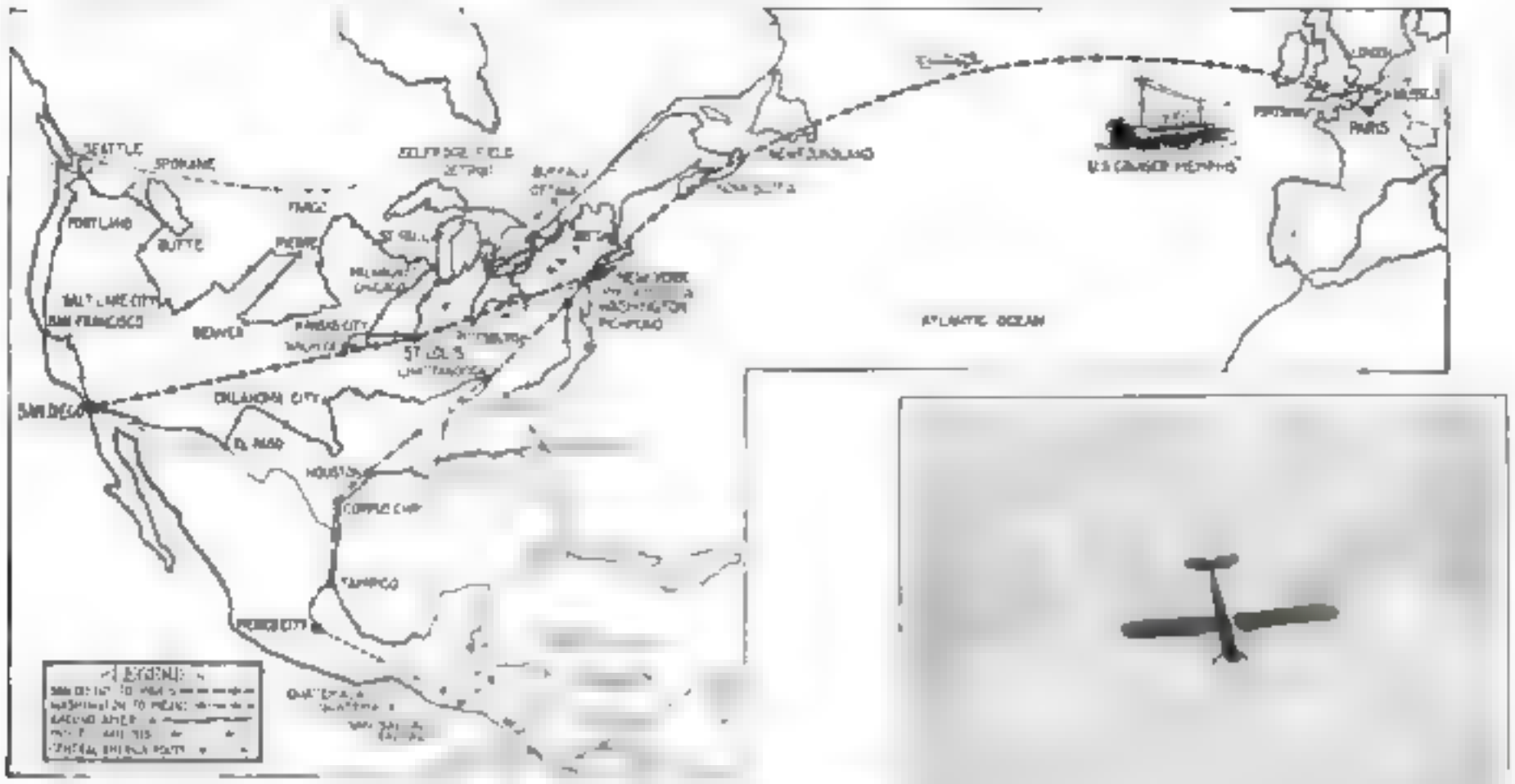
As we grow older, of course, no matter where we live, we acquire a certain degree of immunity to infectious diseases by the same process—constant exposure and the gradual creation of antibodies. But this does not apply to pneumonia and the common cold.

Most of us make the mistake of thinking that good health alone confers a certain immunity to infection. "Give me perfect health and I'll ride the worst epidemic," you hear. Yet the percentage of baseball players who fall victims to typhoid is above the average. Their top-notch physical condition provides no immunity against the polluted water many of them carelessly drink while traveling around the country.

Interesting experiments were made by the late Dr. Reynold A. Spaeth, of the Johns Hopkins School of Hygiene and Public Health.

Of forty white rats, twenty were regularly exercised by forced running in motor-driven drums. The other twenty were left to their own devices. After twenty-one weeks all forty were inoculated with pneumonia germs. Next day the unexercised rats were alert, bright-eyed and normal. But the (Continued on page 161)

"We" Smash More Records



Lindbergh's Plane Good as New After Flying 35,580 Miles

By
ELLSWORTH BENNETT

The *Spirit of St. Louis* Lindbergh at the controls map of their 35,580 mile trip [illegible] with glasses and President Calles wat hing them in Mexico

WHEN Col. Charles A. Lindbergh touched the soil of Central America on his latest "good will" hop, his famous mechanical partner, the *Spirit of St. Louis*, had carried him, altogether, 35,580 miles—nearly equal to one and one-half times around the globe! And this without sign of faltering, and with only a few minor repairs

While the world renewed its tribute to Lindbergh as a genius of flight engineers were acclaiming the triumph of his silver monoplane as one of the amazing mechanical performances of all time. Roaring at a speed far faster than an express train's the machine had within seven months borne its pilot across the American continent, over the Atlantic Ocean, through every state in the Union, and then to Mexico City and Guatemala. And here it was, safe and sound, apparently as fit as ever!

Colonel Lindbergh and the *Spirit of St. Louis* landing at the Valbuena Airport, Mexico City on "good will" flight to Central America

Its air-cooled Whirlwind motor had run for more than 370 hours without a failure, surviving well beyond the average life span of modern power plants of its type, reckoned at [illegible] hours. And it was still turning [illegible]. Indeed, just before the 2000-mile trip from Washington to Mexico City, the master mechanic at Bolling Field, Washington, had gone over the plane and had pronounced it in as perfect condition as the day it left the factory!

The accompanying map shows the long trail of Lindbergh's remarkable flights since the day, last May, when he hopped off from San Diego on his great adventure. It constitutes a picture-record of unequaled mechanical and human endurance.

LINDBERGH'S return from France was quickly followed by a 22,350-mile tour of the country. This was completed without a single overhauling, and with no mechanical difficulties or forced landings. Only one failure of schedule occurred, when Lindbergh decided not to risk a landing in the fog at Portland, Me. When, at the end of the tour, the motor was taken down, mechanics found it necessary to replace only bushings, a rocker arm and two valves—after more than 22,000 miles.

Today the *Spirit of St. Louis* is still good for many more months of service.

Joe McIlroy [illegible] lumberjack, [illegible] author how [illegible] ing Right [illegible] Andreasen [illegible]

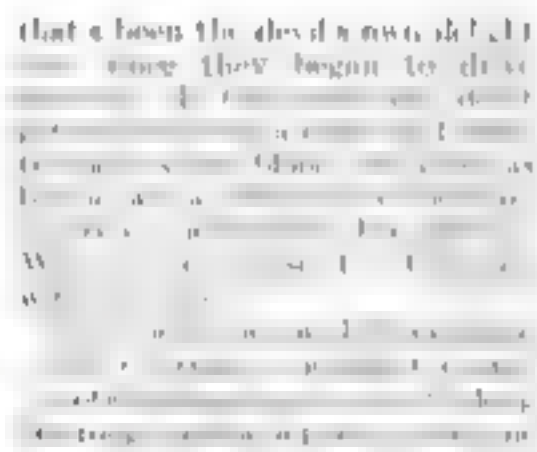
Romance Jams the Log Jams

Lumberjacks Risk Lives Playing with Twenty-foot Jackstraws And Dynamite to Keep Timber Moving in Lakes, Rivers and Rapids

By ARTHUR GRAHAME

THE drive! Pulp logs—four foot lengths of spruce destined for the pulp crushers of the voracious paper mills down river. Saw logs—twenty foot lengths of pine for the band saws of ever-hungry mills. Thousands and thousands of feet of rushing timber, wet and slick, sometimes tossed half hidden by sheets of white spray into the Dakota spring sunshine, sometimes tumbled end over end down breath taking rapids by the fierce swirling waters of well named Rapid River. Above all, appropriate music—the sullen roar of the river and the harsh crashing and splintering of timber hurled viciously against boulders and rock ledges.

Old Joe McIlroy, veteran of forty-odd years of river driving, my guide when I went into the logging country to report a drive for the readers of POPULAR SCIENCE MONTHLY, gripped my arm with a weather-darkened hand and pointed two hundred yards upstream to a long saw log, its butt jammed hard into some crevice in the river's rock bottom. It had swung across the current and lodged its other end behind a boulder. Held in place by the terrific rush of water, it had become a rallying point for other logs, which, hurled against it and up-ended, were transformed swiftly into a confused spray-drenched pile of gigantic jackstraws.



"YOU'VE been wantin' to see a log jam," old Joe shouted in my ear. "Well, there's the beginnin' of a dandy. That there ledge is the worst spot in this whole six-mile stretch of white water

to follow. The trail swung away from the river—but not out of earshot of its roar—into the warm stillness of the woods, then, after a hundred yards, back to the river. In the few minutes that we had lost sight of it, the jam had increased tenfold. It was an uneven, bulging wall of grinding, groaning logs extending across the narrow river. Water shot its way through the many crevices in this wall, but behind it more water, and thousands of logs, were piling up.

High on the bank above the jam, we broke into a small clearing in which stood a rough shack; a man emerged from the brush across the open space from us. He was a lean, slabsided man, whose long, solemn face the winds and suns of many seasons had tanned to the rich, even brown of a long-used saddle. He gave us a brief glance, then turned his clear gray eyes to the jam. After a moment he spoke, with a Yankee drawl and in the gentle voice of the Maine woodsman.

"YOU can't trust this old devil of a river a minute," he observed without malice. "I just went upstream a piece to help the boys out with a little hang-up—and now look at this!" He strode to a telephone on the side of the shack and spoke calmly into the transmitter.

"He's the tender-out," old Joe informed me. "It's his job to watch the river here and see that the logs are running free. Old timer on the river all the tenders-out are. It's a right important job."

The tender-out took up an pickpole a twelve-foot ash shaft with a steel tip fashioned auger wise so a man could thrust it into a log, give it a twist, and then pull the timber as he scrambled down the bank. Now the wall of logs was damming back most of the river's flow, and the water's roar was changed to a sullen murmur that mingled with the cracking and groaning of the logs beneath the terrific pressure. So little water flowed below the jam that the tender-out was able to leap from boulder to boulder into midstream. There, facing the treacherous, trembling timber rising far above his head, soaked by the icy water that spurted spitefully from between the logs, he began to prod and pull with his pickpole at the tangled mass, searching for the jam's key log.

"I saw my brother killed that way," said old Joe. "That was twenty years ago, up north of here on the Swift Diamond. He found the key log all right, and loosened it—but he couldn't get clear in time. Little the logs and the rocks left of him. We picked his body out of a shallow ten miles down. . . . Mighty close that I came to going the same way down there on the Androscoggin, right below Errol Dam. I was on top of a jam, shovin' logs over, when out she went with me. All hell broke loose. I saw nothin' but white water and grindin' logs—and there I was standin' on a big saw log with my peavy in my hands and ridin' pretty in a quiet pool.

"BACK in those days there was none better than me at ridin' the logs. Why, I mind once I rode one through an open sluice-gate, just to show off to my best girl. There's few that knows the trick now. Drives ain't what they used to be, and lumberjacks ain't either. There's not many left in these here woods that can use an ax even. A feller with a cross-cut saw can fell three trees to a good axman's one. I mind when—"

I had been listening to old Joe with my eyes on the tender-out, playing his desperate game of jackstraws down there below the face of the jam, pushing and pulling until the sweat ran down his brown cheeks and the pickpole bent in his hands. Now, as he came leaping toward shore, there was a great to-do of shouting and singing in the brush, and a dozen lumberjacks strode into the clearing. Most of them were French-Canadians—husky young fellows, with dark faces and straight black hair and big-chested bodies—who wore gaudy mackinaw shirts, and carried pickpoles or peavies.

The tender-out came up the bank as they prepared to descend. "It's no good," he said to their foreman. "I'll have to blow her." From a box standing opened and handy at the door of his shack he took three yellow sticks of dynamite and a length of fuse, then went calmly back to the jam. Working unhurriedly and with method, he placed the "canned thunder" where it would do the most good, bent over the fuse a moment, and came unexcitedly back to shore.

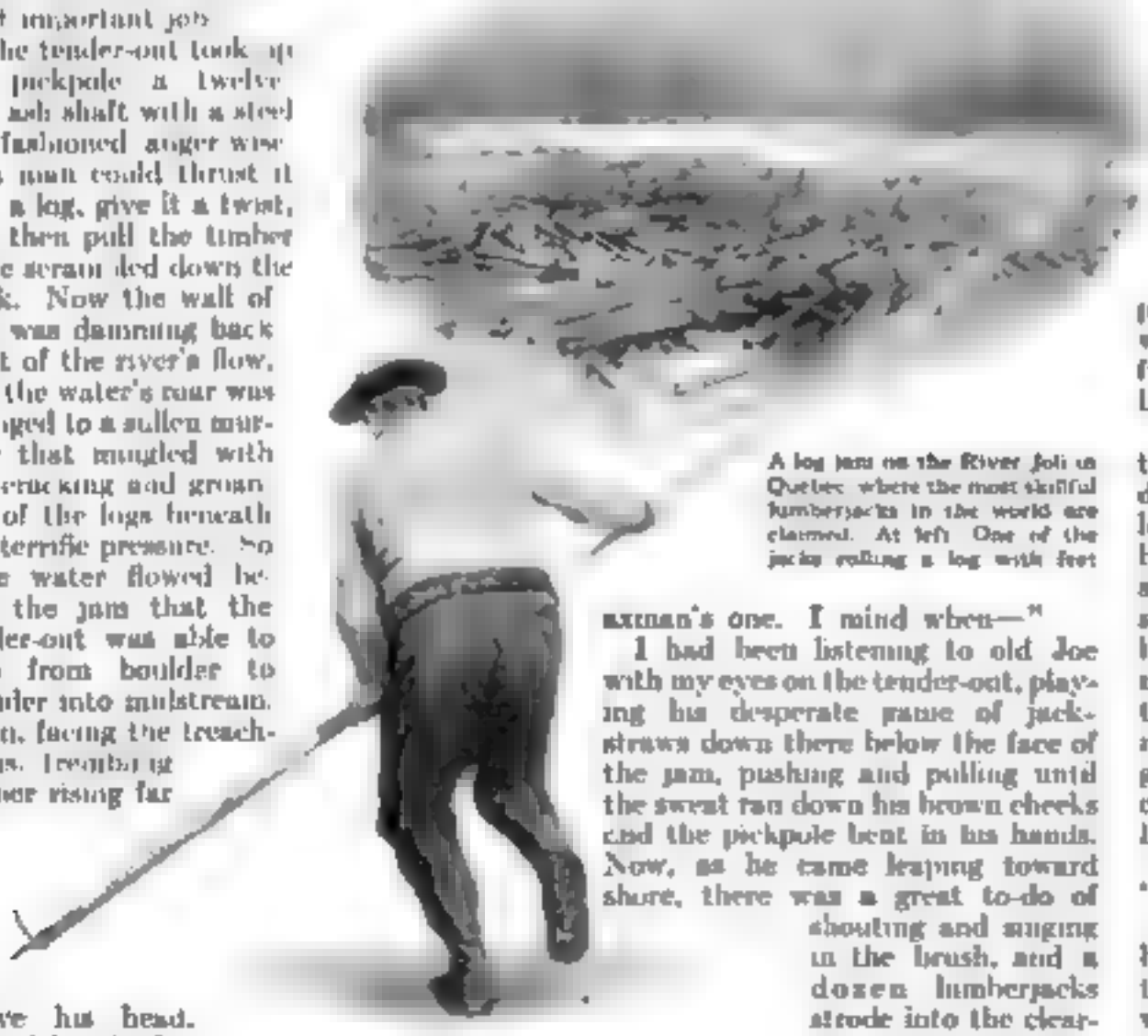
We took to shelter. It seemed a long time before anything happened. Then dull thunder shook the earth, and giant logs, rent and splintered, were hurled high into the air. Before they could splash down again the eager current had seized on the logs beyond them and hurried them on downstream. In a few minutes, old Joe admitted unwillingly, the tender-out, with a few sticks of dynamite, had broken a jam that in "the good old days" would have resisted an entire driving crew for hours, and perhaps hung up the drive for days.

"THEY'RE using dynamite more every year," he grumbled. "It busts up a few logs, but it saves time, and time is worth more than logs these days, with lumberjacks paid higher than they used to."

Many times on the drives I listened to that plaint of the old-timers, "Lumberjacks ain't what they used to be." Perhaps they aren't, but they still do a man's job in driving the logs down white water from where they are cut in the woods to the mills. Those that I watched at work and talked with in their wangans—"wangan" is

(continued on page 124)

A flume built where natural waterways do not serve to carry logs to the nearest river or lake that will carry them on their way to the mill



A log jam on the River Joli in Quebec where the most skilful lumberjacks in the world are claimed. At left: One of the jacks rolling a log with feet

By
FRANK
PARKER
STOCK
BRIDGE

Sperry—Competitor of the Sun

Dramatic Story of Modern Worker of Miracles Which Vastly Increase Safety of Land, Sea and Air Travel

A SPARK blue eyed man with a close cropped white moustache stood on the roof of a tall building on the Brooklyn side of the East River and looked across a mile and a half of space at the skyline of Manhattan. Except for a few illuminated windows here and there, behind which workers lingered at their tasks, the battlements of downtown New York were black against the midnight blue beyond the Jersey hills.

Two men wheeled a stubby cylinder mounted on a trigger tired truck across the roof.

"All set, Mr Sperry," called one.

The white moustached man pulled a switch lever and across the towers of Manhattan shot a blinding beam.

THE Sperry searchlight, culmination of forty years and more of one man's life work, gives a light that is actually brighter, mile for mile of radiating surface, than the sunlight which reaches the earth. That would be enough in itself to stamp Elmer Ambrose Sperry as one of the world's great inventors.

On August 30, 1927 the steam tanker *Pulpit Point* cleared from San Francisco for Auckland, New Zealand. Captain Owens set his great circle course true South 98 degrees West by his gyroscopic compass and turned the wheel over to "Metal Mike." For twenty one days, except for an hour in detouring the Savage Islands, no human hand touched the helm. There were cobwebs on her steering wheel when the Auckland pilot clambered aboard.

The Sperry gyrocompass and gyrosteering device, apparitions to useful work of what was merely a physicist's toy, would alone mark their inventor as one of the world's most original thinkers.

BUT the acclaim of the scientific world for Elmer Ambrose Sperry is not based upon these achievements alone. Some call him the greatest living inventor, others, second only to Edison. There are men with more patents to their credit—he has only four hundred or a few more—but no other man has covered such a variety of fields, and certainly not more than one or two others have made inventions so fundamental and revolutionary. Most inventions are adaptations or improvements. Sperry's are basic.

ONCE in a while the public hears of Elmer Sperry, as a vague figure behind some demonstration of a new light or a new application of the gyroscope (spell "g," please), or when his professional associates honor him with the Collier medal for aviation, or the John Fritz Medal, the highest honor that can be paid an American engineer by his fellows, which was awarded to him for 1927. But the public never sees him. It is not of record that he ever presided at a public dinner or made a public speech.

But he will head the commission of seventy engineers representing the United States at the International World Congress of Engineers at Tokio in 1929.

In Chicago there is a fourteen acre plant devoted to the manufacture of electric railroading machinery invented by Sperry.

In Niagara Falls are two great electrochemical industries making caustic soda and chlorine salt, based upon Sperry inventions.

In Baltimore a factory utilizes the

One of the early Sperry street cars, first that could climb steep grades, built about 1894. Sperry, in derby hat, holds lever on truck behind the car

scrap from all of the tin can factories of America, recovering the tin and selling it to the silk weavers and melting down the remaining iron scrap into such things as sash weights—entirely based on Sperry patents.

The General Electric Company bought the Sperry patents on electric street cars capable of climbing steep grades

In Brooklyn the Sperry Gyroscope Company, which makes the gyrocompass, the gyrosteerer and the gyrostabilizer for ships, and builds the Sperry searchlights, occupies a twelve-story building at the end of the Manhattan Bridge

Every navy and great merchant fleet in the world uses these Sperry inventions for navigation Every navy and most of the armies use Sperry searchlights The Sperry aerial torpedo and a dozen other war machines, some of them among our Government's most closely guarded secrets, stand to his credit

WHEN Prof A A Michelson the great physicist whose investigations of light are of extreme importance in scientific research, needed a light equal to sunlight for his experiments, Elmer Sperry alone could furnish it. And when Professor Michelson's work called for flywheels with the incredible speed of 40,000 revolutions a minute, Sperry alone could design and build them

The navigators of the air mail find their airports by the aid of Sperry searchlights, their beams visible as far as 140 miles from their source, sending a billion and a quarter candlepower into the sky

Practically all motion pictures today are made in windowless studios, for the Sperry carbons are light makes possible better lighting effects, even for supposedly out door scenes, than the sun itself

Why, I wondered, with such achievements to his credit doesn't the public know more about Elmer Sperry the man? I went to see

I found him at his desk in Brooklyn His tanned face and springy step belied his sixty-seven years

"GOLF" he said, as we spoke of a mutual friend, now long passed into the beyond. "golf would have kept him alive He didn't know how to play He spent all of his time working the worst thing any man can do."

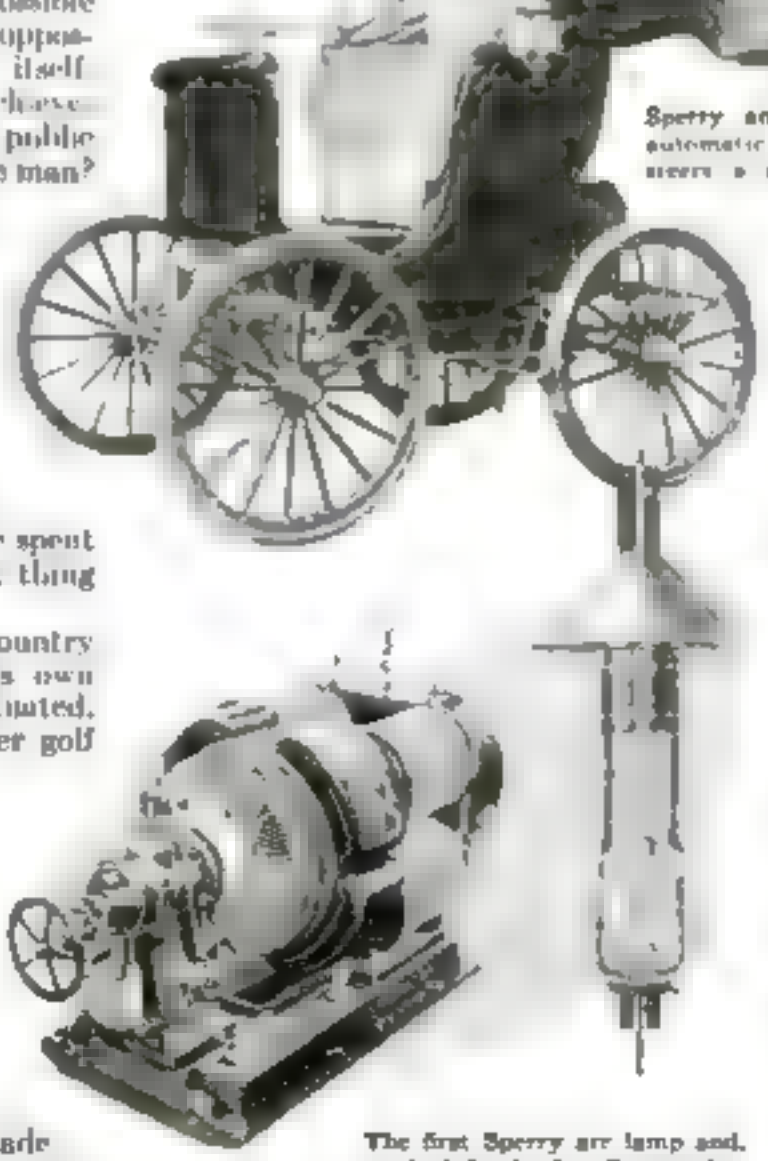
Sperry is a member of three country clubs on Long Island, where his own magnificent summer home is also situated, at Bellport. And he plays better golf than many men of his years. Yet this same man works longer hours than any other man but Edison

The thing on which the great inventor is working now is an electric fissure detector, to discover and mark faults in railroad rails by electrical measurements made while a car containing the instrument passes over the line On a length of railroad track set up in his factory tests are being made

What may prove his greatest invention is a radically new type of aviation engine, which weighs no more per horsepower than the best now in use which requires a third less fuel to produce the same power and that fuel costing only a tenth as much as gasoline and non-inflammable. It doesn't take much imagination to appreciate what such an engine will do for aviation, especially as it has no complex electrical equipment to get out of order.

Elmer Ambrose Sperry, one of the greatest living inventors and one of the least known to the public his amazing engineering genius and creative power are equaled by his modesty

Below: An electric automobile built by Sperry before gasoline became the standard for horseless carriage propulsion. For this he devised a rapacious storage battery still utilized today for other purposes



Sperry and "Metal Mike" automatic helmsman that steers a ship by the gyrocompass It resists every wave that turns the ship from its course

The first Sperry arc lamp and, at the left, the first Sperry electric dynamo which provided the current. From a tower in Chicago a battery of these arc lamps cast 40,000 candlepower, a marvel of the nineties

THAT is the supercharged Diesel type airplane engine which Sperry has developed after nearly thirty years of experiment. He has built a number of supercharged engines of other types, many of them being successfully used in racing cars and airplanes, but he never was satisfied with the four-cycle gasoline engine it seemed too complicated ' The Diesel engine is supremely itself once the weight factor can be cut down ' he told me

Everybody realizes now that the failure of so many long-distance flights was due to the weight of the gasoline which had to be carried Crude oil or distillate, which is the Diesel engine's fuel, weighs a third less and my problem has been to find a way to make it give more power per gallon with no increase in the weight of the engine over the best of the gasoline type '

There were many complications in the problem, but the present engine, the eighth in the experimental series, is said to have solved them all

"WHAT is your latest application of the gyro?" I asked.

"The automatic track recorder he replied "That was first used about a year ago. It is used by railroads to determine the condition of the roadbed. The gyroscope, as you know, can tell if the object with which it is in contact is moving, and in what direction and if tilted, just how many degrees This track-recorder mechanism is mounted on a railroad car and run at any speed. It makes a record on paper telling just the degree of banking on every curve, whether the rails have spread at any point, whether the ties are firmly bedded or are center-bound, so that one end sinks under the weight of the train The engineers can take the picture the gyroscope draws and send their repair gangs to the precise points where things are wrong "

The recorder has been in use on the Santa Fe railroad for about a year, and is now being adopted by other roads.

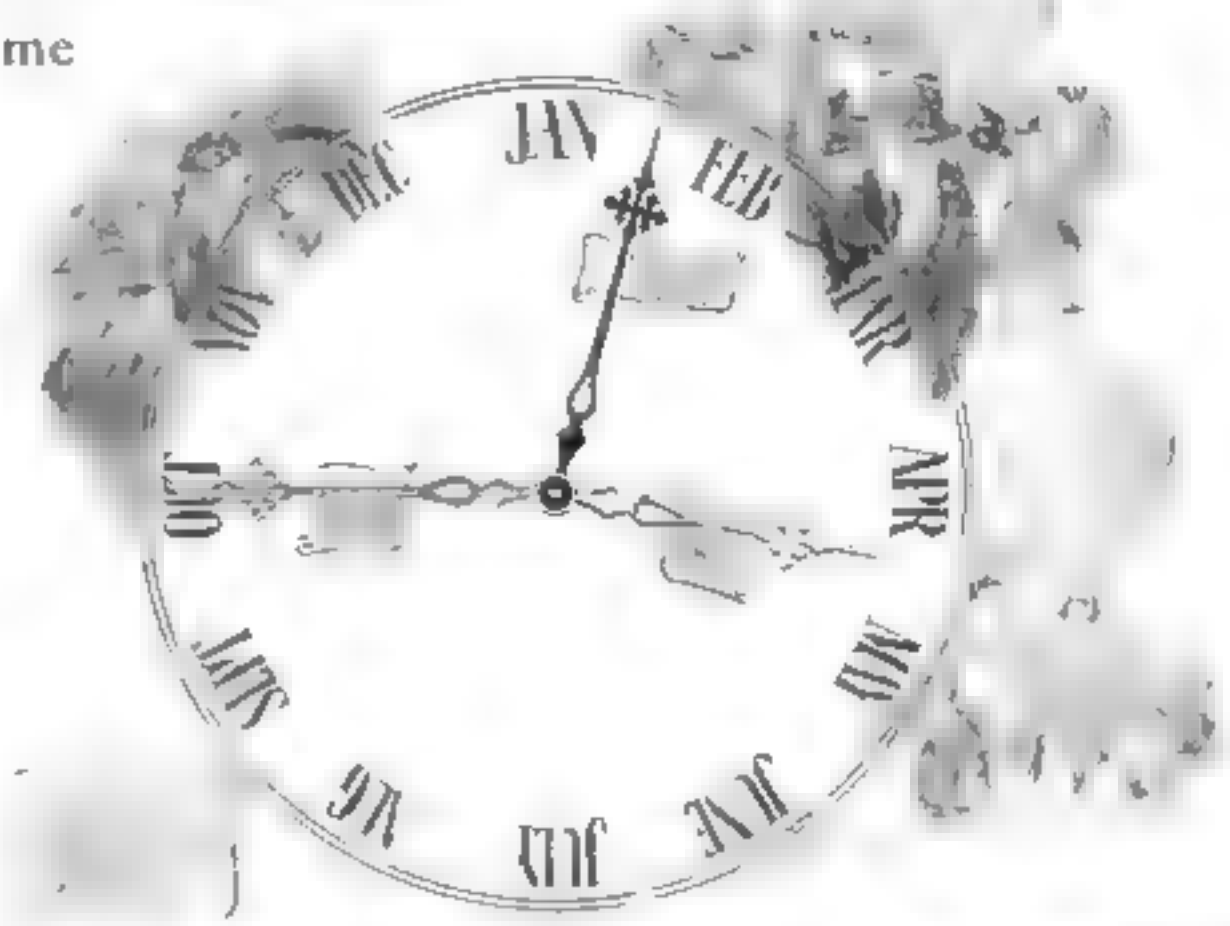
"I wish you'd explain the working of the gyroscope to me," I persisted 'What can it do? And how did you come to think of putting it to work?"

He picked up a brass model from his desk. Just a little flywheel heavy at the rim, light at the hub. Each end of the long axle was held in a bearing in a ring of brass, just big (Continued on page 102)

Where *Did You* Catch Cold?

Maybe from Heavy Meals, Smoking, Kissing, or From Your Neighbor—Some New Discoveries about Our National Malady

By P. A. CARMICHAEL



THOMAS A. EDISON has said that the American people eat too much. The great inventor speaks with authority; he knows the importance of right eating. To the fact that he has long kept to a light diet he attributes much of his ability to work more hours a day than most men.

If it is true, as many doctors maintain, that we literally eat ourselves to death, it is not surprising that we sometimes eat ourselves *sick*. But how often does it occur to the man, woman, or child suffering with a cold that he or she has caught it from eating?

Yet what we eat has been found to be the primary cause of many of the colds with which we as a nation suffer. Take, for example, the banquets, parties, and Sunday dinners when we are tempted to overindulge our appetites for rich food. We may soon suffer from sluggishness or indigestion, but we also are inviting that insidious ailment for which we usually blame the weather or somebody's sneezing—the common cold.

Dr. Volney S. Cheney, medical director of a Chicago packing plant, suspecting that colds among the employees were due largely to overeating, kept a record of them and found strong evidence that his suspicions were correct. On days after banquets and on Mondays and days following holidays, the prevalence of colds was greatest.

The explanation, Dr. Cheney said, was fundamentally the eating of too much meat and other protein-containing food. This unbalanced the system, generated acid poisoning, and combined with lack of exercise and perhaps with other ailments already present in the body, paved the way for colds. The remedy, he said, is a diet containing plenty of vegetables.

We not only eat ourselves into colds, but some of us smoke ourselves into them. Many a man, intent on some task, excitedly lights one cigarette after another and presently finds himself hoarse.

"WHAT have I done to catch this infernal cold?" he asks. He runs over the events of yesterday and the day before, but can think of nothing he did then to induce a cold. The consequence is, he ascribes it to some mystery in Nature.

Let us suppose he had gone to a doctor. The latter would have examined his throat and, finding it inflamed, probably asked whether he smoked. When the patient had recalled his excessive smoking of the day before, the explanation would have been clear. It would have been this: The smoke irritated the delicate mucous membrane of his throat, allowing the germs constantly inhabiting the mouth and throat to penetrate the flesh and set up the inflammation.

Sometimes a surprisingly small amount of precaution will prevent such a cold. For instance, Dr. Russell L. Cecil, professor of clinical medicine at the Cornell University Medical College, reports cases in which even a change in the brand of cigarettes has been effective.

COLDS of this kind show how it is possible to contract the ailment without exposure to other sufferers or to bad weather. The reason is that we are constantly beset by an army of microbes camped in our mouths and throats. These invisible invaders are always ready to attack. Of course, they do not succeed at every opportunity, for there is an opposing army of corpuscular defenders in the blood which, when the system is in good order, usually repulses them.

Not only excessive smoking, but such things as dust and gases, extremely cold, dry air, over-use of the voice by speakers and singers, and digestive disorders, which send up substances that roughen the membrane, may cause colds.

This is one kind of cold. There is another.

When you kiss your maiden aunt—or, for that matter, your best girl—when you shake hands with a friend you haven't seen for six months; and, of course, when you fall within range of the fellow who charges the atmosphere with germs by coughing and sneezing—when, in other words, you come in contact with carriers of the germ, you are in danger of catching this second variety of the disease. Strange to say, this kind is contagious; whereas the other kind, which we catch without contact and without exposure, is not.

To demonstrate the contagiousness of the second variety, Dr. Peter K. Olitsky, of the Rockefeller Institute for Medical Research, conducted a series of interesting experiments. He took washings, or cultures, from the throats of cold sufferers and with these swabbed the throats of several well persons. The result was, with few exceptions, that he produced typical colds. In the cases where the colds failed to "take," the persons from whom the cultures were obtained had been infected eighteen to twenty hours, whereas, in the other cases, the infections were only a few hours old. All of which indicated that colds are communicable in the early stages but not in the later.

So far as medical science knows, the agent which causes colds may be so minute as to be invisible under the most powerful microscope. Dr. Olitsky put all the washings he used through the finest filter, thus straining out all the known bacteria, and yet transmitted the disease. He concluded, therefore, that the cause is apparently a filterable virus.

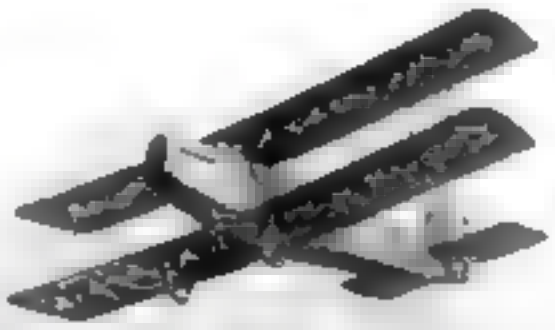
GENERATIONS of warnings against exposure have left in most of us an almost instinctive dread of cold or damp weather, in which, we think, there lurks our death of cold. Lately this idea has been widely challenged. Colds, we have been told, are not caused by exposure, but by germs. The question has been investigated experimentally, just as was that of the transmission of colds, with the result that we now have the findings of science for a guide.

In St. Louis, at the Washington University Medical School, a group of volunteers submitted (*Continued on page 130*)

A New Brood of Lindberghs

How Uncle Sam's Sky Classrooms Are Teaching Awkward Fledglings to Become Great Flyers

By MAJ. GEN. JAMES E. FECHET
Chief of Air Corps, U. S. Army



FIFTEEN hundred feet above Brooks Field, San Antonio, Texas, a biplane skidded uncertainly in wide-sweeping circles. In the cockpit a goggled young flying cadet, right hand clutching the "stick," feet moving gingerly on the rudder controls, struggled in the grip of a strange predicament.

Here he was, up on his first solo flight—and for the life of him he could not get down to earth again! Worse still, the fuel tank was running dangerously low!

For fully half an hour he had been chasing round and round that endless circle, hawklike. Directly below he could see a curving row of little bird houses—the hangars and barracks of the flying school. Beyond, to the southwest, miles of farm land stretched away toward the Gulf of Mexico.

HOW to get down? He tried to repeat to himself the directions often given by his instructor. He tried to bring back the "feel" of the ship on previous occasions when with dual controls the veteran pilot had demonstrated to him how simple it was to land. But try as he would now, he could not bring himself to make the dive to earth.

On the ground a group of officers signaled frantically.

"If that boy is sitting around up there waiting to fall down," grumbled one, "he won't have to wait long."

Almost as he spoke, the engine of the plane missed, sputtered and died. The officers watched anxiously. A stall, a sickening tail spin—anything might happen now. Instead, to their surprise, they saw the nose of the machine sink slowly and deliberately. With a graceful glide, the powerless plane winged downward until it swept to a perfect landing!

The cadet stepped from his ship, grinning sheepishly. The officers, vastly relieved, could only shake their heads and laugh at this "ground shy" fledgling who could rise to the do-or-die emergency with instinctive resourcefulness and find his wings. True, he had brought the emergency upon himself, but in meeting it he had laid claim to that coveted possession of every great pilot: the flying instinct.

With a fresh supply of fuel the cadet took off again, and again landed, this time under power. Time and again he repeated the performance until his original slyness of the earth had been conquered. Today, having completed his schooling, he is a crack pilot of a large eastern air line.

One of the many thrilling experiences of the advanced air students, sometimes for practice and sometimes to save their lives when they get into difficulties — a parachute jump. The flyer is seen below the airplane which speeds on, the parachute is just beginning to unfold

Major General James E. Fechet, Chief of the Air Corps of the U. S. Army

ON the first of this March more than two hundred ambitious young men, like this cadet, set out to try their wings at the two Primary Flying Schools of the Army Air Service—at Brooks Field and at March Field, Riverside, California. They are from virtually every state in the Union. Most of them never have ridden an airplane, nor have they a clear idea of how it is built or how it works. But all are fired by the desire to fly and by the ambition to find a successful career in the air.

SOME are destined to succeed spectacularly; some will prove to be naturally unfit and will turn to other pursuits for which they are better adapted. From this raw bunch of groundlings, however, will emerge men who will be among the great pilots of tomorrow—men trained in the same thrilling school of experience that helped to produce a Lindbergh, a Chamberlin, and many another successful flyer of today.

They will find many opportunities as officers in Army flying units, in mail or the varied commercial air lines, in designing and building airplanes. The whole fascinating realm of aviation, you see, opens before these prospective pilots.

Under the Government's five year program of expansion in aviation, the Air Service stands in need of skilled officers. That is a chief reason these youths are being given the great chance. At present our air forces are undermanned. We have less than a thousand pilots, less than 9000 enlisted men, and 205 flying cadets. Under the new program we shall require at least 1650 commissioned officers, 1800 serviceable airplanes, and 15,000 enlisted men, including 500 flying cadets.

Training planes lined up at Brooks Field, Tex., Primary Flying School, ready to start the day's flights shortly after 6 o'clock A.M.

BUT to enter a Primary Flying School one must measure up to definite qualifications. He must be between twenty and twenty-seven years old with two years' college training or its equivalent; sound as a dollar physically, with perfect hearing and sight, and well recommended as to character.

Arrived at the flying field the

Testing student's reactions to rarefied atmosphere such as he will have to breathe in high flight

beginners are brimful of enthusiasm and confidence, but before many days they began to wonder if this flying thing is as simple as it looked.

To be sure, almost anyone can learn to fly an airplane, but to be a successful military pilot a man must fly instinctively, as if his ship were a very part of himself. Such a pilot is Lindbergh. It is the so-called "inherent flying ability" that enables a military pilot to make half a dozen split-second decisions in an emergency, or to perform such tasks as map making and photography with hardly a thought of the mechanical operations of flight itself.

Consequently, the earliest experiences of the flying cadet are those for determining whether he possesses this elusive quality—whether he is a born flyer.

MOST surprising is a machine known as an orientator, which reveals the man's ability to "find himself" when whirled and tumbled about by the evolutions of a plane. In a cockpit suspended within three concentric rings, the "pilot" is looped, rolled and spun through every conceivable experience and must bring himself back to an even keel after each upset.

There are other ingenious testing devices—for example, a whirling chair that determines a man's sense of equilibrium, instruments that test his judgment of distance, machines that measure how readily his muscles respond to a sharp command or a flashing signal. In addition, searching questions disclose his family and personal history, his habits, peculiarities and temperament—all this to reveal any nervous weaknesses which later might cause him to break under trying circumstances.

Some time ago one of the most brilliant cadets crashed two days after his graduation. Later it was discovered he had been subject to occasional fainting spells which somehow had escaped the qualification inquiry.

The first two weeks—all "ground work"—pass somewhat tediously for the boy who is impatient for the air. In the first week he must learn military fundamentals; during the second he gains his first knowledge of the theory and mechanics of flight.

THEN the third week brings the great day when he goes up for his first actual flying instruction.

Proudly he appraises the machine he is to ride. It is a PT-1 special training biplane, designed for stability and low landing speed, and driven by a 150-horsepower motor. Its fuselage is all metal, with strength to withstand a severe crash. The instructor climbs into the front seat, and the student takes his place in the rear. That first flight is little more than a sight-seeing tour, with the instructor presiding, but the pupil acquires something of the feel of the ship. Next morning the cadet has his first lesson in handling the controls. These are in duplicate, one set for the instructor, the other for the pupil. On the edge of the upper wing are mounted the instruments in view of both men—air speed indicator, altimeter, tachometer and oil gage. As they fly the men converse through speaking tubes connected with the earpieces of their helmets.

"Hold the stick—lightly now . . . Now your feet on the rudder bar." The future pilot obeys the commands, studying the movements of the mechanism and the response of the ship.

FOR days this sort of training continues. Then at last, at a height of about two thousand feet, the instructor holds up his hands to show that he has relinquished control, and the youngster has his longed-for opportunity. Nine times out of ten, the plane begins to skid and slide crazily about the sky and the instructor comes to the rescue. But soon the pupil finds the nice balance between rudder and ailerons that keep the machine straight and level. Every day brings some new achievement—first gentle turns, then steep turns, spirals, and landings, then aerial acrobatics, especially the tail spin. Almost invariably, when a pilot stalls his plane, it goes into one of these vertical spins. The controls go limp, and have no effect. Eventually the student learns the trick of getting out of a tail spin by kicking over the rudder to form a pocket which catches the air, lifts the tail of the ship and brings the nose down.

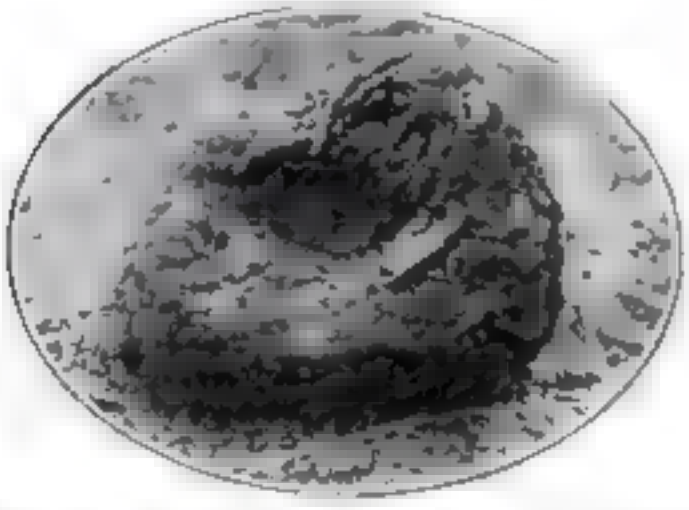
After about twenty half-hour flights with his instructor the pupil, if he has shown steady progress, is ready for "solo work." If he has failed to progress, he faces the "benzine board." Other instructors go up {Continued on page 152}

Upper photograph: Flying back over head, the cadet tries to right himself in the orientator, a cockpit operated to duplicate the evolutions of a plane by the instructor seated near by. Middle: Testing vision. A cadet at either flying school must see perfectly without glasses. Lower: Flying cadets learning how to repair wings, fuselage and propellers in the woodworking shop of the school

Bits of Old Clay Kick up a Big Row

Bitter Dispute Divides French Archeologists—Are Carvings Dug Up 10,000 or Only 10 Years Old?

By GEORGE LEE DOWD, JR.



A Glozel find. A clay block that may have held a Stone Age idol. Did caveman or a joker make it?

Part of the "Museum of Glozel," showing some of the relics of which it is the crude temporary repository. The most interesting feature of this group is constituted by the strange bowls which represent human faces with eyes but without mouths

THREE thousand so-called prehistoric relics, dug from clay two feet under the soil of a peasant's farm in the hamlet of Glozel, France, today have divided French archeologists into two bitterly hostile camps in a controversy to determine whether a fascinating new chapter shall be added to the early history of mankind.

One group of experts pronounces the relics the most important of European archeological discoveries. In seemingly ancient stone implements, weapons, vessels, carved bones and inscribed tablets they find evidence of a remarkable Stone Age civilization which they believe existed in Western Europe perhaps as long ago as 10,000 years—more remote than ancient Egypt.

Opposing these Glozel believers are equally respected experts who contend that the entire "find" is a gigantic hoax perpetrated by some industrious jokesmith.

THE conflict came to a head a few weeks ago in the report of a special International Commission of Anthropologists, eight in number, appointed to decide if the relics were genuine. The report called the "discovery" little more than a daring and ingenious fake.

But this finding only fanned the conflict to greater heat. Immediately the Glozel believers charged the commission with bias and fraud and, led by Saloman Remach, Director of the Museum of Saint Germain-en-Laye, took their grievances to the French courts. There the matter boils at the present writing.

It all began in 1924 when the plow of a French peasant, Emile Fradin, turned up a number of curious and apparently ancient implements and inscribed clay tablets. Dr. Morlet, a physician and antiquarian living near by in Vichy, became interested. Searching farther, he and others unearthed thousands of vases, axes, flint arrowheads, bone harpoons, stones with ground edges, fragments of glass vessels, and also evidences of an ancient tomb.

Chief interest centered on the carved tablets, seeming to indicate that prehistoric cave men used an alphabet centuries before the ancient Phoenicians, generally credited with the invention of the ABC's. The inscriptions included more than a hundred signs and characters. Curiously, half of these bore striking resemblance to Phoenician, old Greek, Etruscan, Latin, and other ancient writings. Certain symbols were similar to those found in such far separated parts of the world as Peru, New Zealand, Scandinavia and Mexico. Others were entirely unrecognizable.

AMONG other surprising discoveries were more than a dozen clay figures representing the human face, with round eyes, but without trace of a mouth! Carvings of reindeer heads appeared on small stones and pieces of bone.

Reinach attributed the relics to primitive people who probably were common to what are now France, Spain and Portugal. Later they vanished possibly migrating to the east under pressure of invaders from the north. This, he says, might explain the similarities between the Glozel inscriptions and the writings of early Mediterranean peoples.

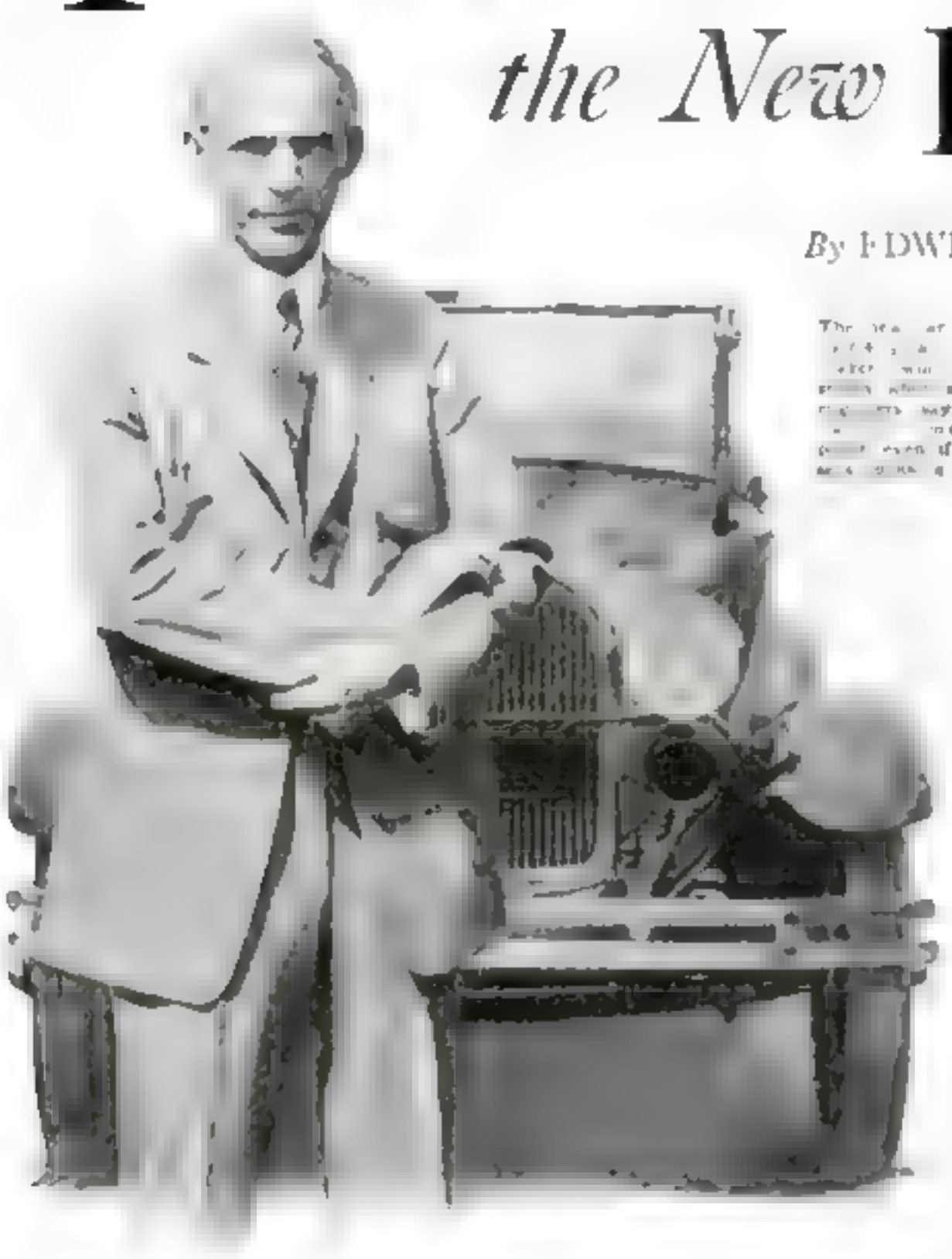
"The collection," says the commission, "is simply the invention of someone who had wit enough to place some genuinely old axeheads and other fragments with others of bone and pottery which he had carefully and patiently fashioned himself."

The commission contended that the carvings bore every evidence of having been cut with modern metal chisels, that an "ancient" oven unearthed was not over seventy-five years old, that many of the "prehistoric" bones actually were new.

The scientific jury gets first-hand information by visiting the scene of the find—or the "crime" of fakery, as they adjudged it—on the farm at Glozel, France

The Real Story Behind *the New* Ford Car

By EDWIN KETCHUM



DOWN a Michigan road, not long ago, rattled a dilapidated "tin lizzie." Over the steering wheel crouched a tall, gaunt, gray-haired man; a small boy at his side.

Henry Ford was the man. The car was a new Ford, secretly built and disguised under a body of ancient vintage. The small boy had been picked up along the roadside because Henry Ford wanted from his lips an unbiased opinion of his new car—an opinion he could get in no other way.

Ford's new cars, already dotting the highways, are the climax of the most spectacular drama in the history of the automobile. One man, by sheer driving personality, dominated it. Success, wealth, fame were his, yet he would not sit idle and let others build his new car. Ruthlessly he scrapped men and machines and started over again. At sixty-four he undertook the hardest task of his life, harder even than the production of his first car more than a quarter of a century ago. He was everywhere at once, passed on every idea, tested most of them personally. Never before has there been such a story of an emergency autocratic control of a mammoth industry—of inventive persistence, and inventions made to order on a huge scale.

Ford seized the first new model as it came from the assembly line at the great Fordson, Illinois factory. "Is this the best you can do?" he asked his engineers. "Yes," they told him. "I'll represent the public, then," he said, and a second later the car, with Ford at the wheel, leaped out upon a near-by field. When he returned, after bumping over stones and logs, he declared, "Pretty good, but it bounces. Put on hydraulic shock absorbers."

AND so, day after day, the new Ford was changed and modified and improved. Ideas for integral parts came from chance remarks of his aides, sometimes on country drives far from the designer's room. Frequently Ford would enter his factory, already engaged on

The [illegible] and [illegible] just [illegible] some [illegible] may be [illegible] make [illegible] even if he [illegible] a day

production, and say, "This part is not right. Let's try it this way!" A part would be built and tried. If it didn't work, the idea was scrapped and a new one developed. Trial and error on a titanic scale!

I went out to the great Ford experimental laboratory near Detroit a few days after the new car was announced to the public to find out the unpublished details of the gigantic new start of the Ford Company. Yet at that great plant few people really knew anything about the things I wanted to know. But Sorensen knew—Charles E. Sorensen, Ford's right-hand man, in charge of production. And it was to him I went first.

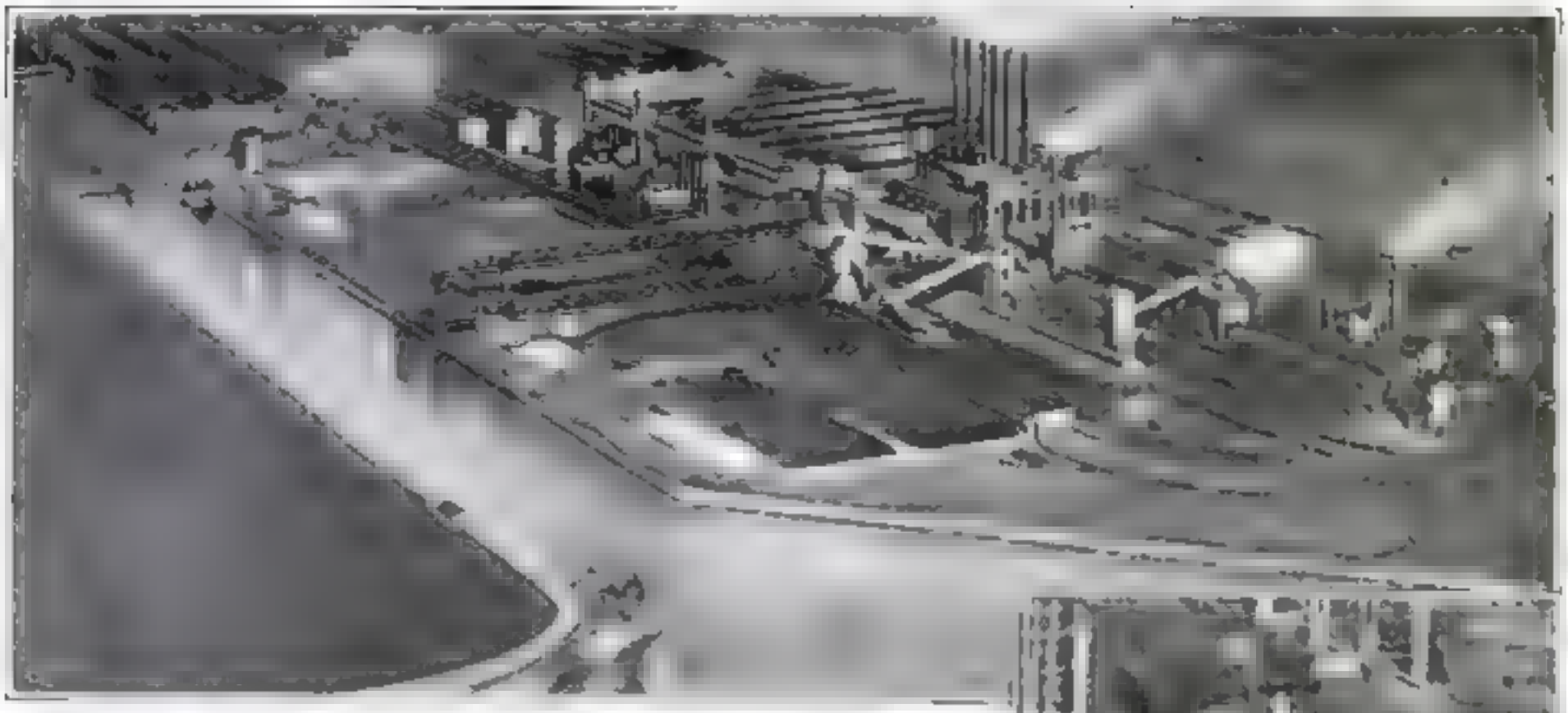
Better steel at lower cost would be needed for a better car. That was decided several years ago when the new car was first discussed. Mr. Sorensen and a few others, a very few others, knew, therefore, just why Ford purchased obsolete vessels from the Shipping Board and acquired a glass factory and new timber lands. Henry Ford was going to produce a new car from his own raw materials in his own factories.

THAT was the program Ford outlined for himself in 1924. To carry it out he had to scrap the costly machinery of the largest and most successful automobile factory in the world. For weeks great machines had to stand idle. Thousands of men had to be thrown out of work temporarily. Ask any business man what it means in dollars and cents to stop such a plant for even a day, and you will have some idea of the courage it took Ford to determine to build a new car whose success no one could foretell.

First there was talk of making the momentous shift after the ten millionth "lizzie" had been made; but "there never seemed to be an opportunity to get the new car started," Ford said, so the fifteen millionth Ford was set as a tentative turning point.

Meanwhile Ford laid down his fundamental orders. "Build a car designed for a need, not any definite price," he told his engineers. Specifically, he demanded a machine that could go sixty miles an hour.

A mile a minute! That called for a forty-horsepower motor. Shall it be a four-cylinder car or a six? Ford demanded a low-speed motor. Such an engine, spinning its crankshaft 2600 times a minute, can develop forty horsepower with four cylinders. A four it was to be, then. "Better make the cylinder chambers about as wide as the distance the pistons



Henry Ford's River Rouge plant, which in 1924 covered 65 acres and now, as one of the buildings at the new Ford plant, occupies more than 115 acres. This does not include the area devoted to breaking up 199 railroads to obtain the raw material for making the new Fords

travel up and down," Ford directed, explaining that he favored the "square" engine with bore and stroke of the same size.

So Ford, master engineer and his staff built into the motor all that was to give his creation an entirely new color from the ground up. Strength. That must be the keynote of the crankshaft—the sturdy looped whirling shaft through which power from the aluminum pistons flows to spin the car's wheels.

Was it balanced? In action as well as at rest? Ford wanted to know, for if it was even a trifle unevenly weighted, it would vibrate and shake the whole car. A precision testing machine proved its balance.

THE engine was satisfactory. "All right," Ford said, "Build a compact car around it. A light car, but one that will hold the road." Some of those engineers may have told their wives that the task was impossible, but they didn't tell Henry Ford.

It is the "unsprung weight" of a car, the weight of the wheels, axles and everything not hung on springs, that jolts and bounces when it strikes holes in the road. Ford found unsuspected ways to eliminate unsprung weight—a rear axle housing of spun steel, steel-spoke wheels, changes in the front axle and the new four-wheel mechanical brake system, all lighter without loss of strength. Even the springs themselves, usually attached to the axle by their heavy end, were reversed so that their own weight would be "sprung"!

Now an up-to-date gear shift was required—a break with years of Ford precedent. The frame itself, forged throughout, for strength. Colors, too, for the body—Edsel Ford chose for his father the two shades of blue, the gray, and the sand-color that became the new finishes. Accessories? "The best," Ford said. Even the old familiar "squawker" horn was scrapped.

THERE was the car—on paper, but there were no machines in existence that could make, in quantity, some of the things that Ford had put in it—a gasoline tank electrically welded of steel covered with [illegible] rust and also for example.

Welding seemed to [illegible] machines couldn't make the gasoline tanks because the current sputtered and faded momentarily as it flowed through the bearings to the welding disks. One of Ford's men hit upon the scheme of running the bearings in mercury, a good conductor of electricity, and that problem was solved.

To spin hot metal into rear axle housings, a device like a huge potter's wheel was invented. Instead of clay, it whirls a red-hot forging; a special forming tool pressed against the metal flattens it into the dish-shaped housing. Now that machine makes three a minute.

Thus new machines were invented. Existing ones were modified. Ford found that he must scrap and replace a quarter of all his machines, valued at forty-five million dollars! Half could be made over the remaining quarter could be used as they stood.

The secret of the Ford success has been mass production, developed to a degree that left men of lesser imagination gasping. Now he would make them gasp again. He would not only make the cars, but make the materials that went into them. Besides his own steel plant, he built a factory to manufacture unbreakable three-ply glass for his windshields. Fuel for his plants came from his coal properties in Kentucky and West Virginia. His Michigan timber lands supplied him with wood. Obsolete vessels went into his furnaces and emerged as metal for his cars.

Then Ford faced the greatest decision of his life. Should he stop the plant in the midst of production and go ahead with the new model? Or play the safe course; stick to the old familiar car and the parts business? Millions were at stake.

Welding gasoline tanks with machine invented for the purpose. Mercury keeps the current constant

"We'll make the new car now," he said, and one spring day of 1927 he drove the fifteen millionth old-type car off the Highland Park assembly line. Then the plant shut down.

Out came the old machines at Highland Park and Fordson. New machines sprung up—among them forging presses that shaped frames of cars at one mighty blow.

Then came the Fordson plant's gala day. Down the assembly line rolled a shining new car with Sorensen at the wheel. Behind it came a second, a third. Here was the new Ford!

And yet Henry Ford wasn't satisfied. He disguised a few of these first cars and started picking up small boys around Dearborn to get their verdict. He got it and gave the machine to the public.

How much did it cost? No one knows. A staff of accountants could easily find out, of course. The point is that they don't. Ford apparently doesn't care how much it cost and obviously he isn't worried about those engineers who say he can't make money on the new car.

"When we began work on the new model, we had $350,000,000 in the bank. Now we have $250,000,000," he said.

That is the story of how one man built a car that set the world talking.

What We Owe to Newton

The Story of a Farm Boy Who Built Queer Toys, Made the Universe Hang Together, and Became One of the Supreme Discoverers of All Time

By ARTHUR A. STUART

AN ENGLISH farmer's son, rather dull in his early school days, who carved his name on a stone window sill when he should have been conning his lessons and spent his leisure at home in making doll furniture for girls and queer toys for himself, received the homage of the civilized world during the last year on the two hundredth anniversary of his death.

He was acclaimed as one of the supreme discoverers of all time, a scientist with few equals through human history.

If Darwin and Aristotle are excepted, who else can stand beside him who found the laws underlying the movements of all celestial bodies and put into mathematical form the poet's music of the spheres?

Sir Isaac Newton made the universe hang together by the bonds of gravitation. He guaranteed the scheduled arrival and departure of every heavenly body, whether speeding hundreds or thousands of miles an hour. He proved the reign of physical law on earth and extended it to the utmost abyss of space. He replaced chance with certainty, fear with rational assurance and superstition with knowledge. He increased the dignity and stature of man. Someone has said that all of us today are standing on Newton's shoulders.

NEWTON'S SIX GREATEST WORKS

By discovering gravitation as a universal law, he brought order out of chaos, knowledge out of superstition.

His improved methods of calculation placed knowledge and achievement on a basis of mathematical precision.

He guaranteed the movements and positions of heavenly bodies, and so made safe, exact navigation possible.

His spectrum analysis of white light paved the way for a host of useful optical discoveries and inventions.

He originated a mathematical basis for all modern physics. For isolated facts he substituted the rule of law.

He invented the reflector telescope. By study of the stars he gave to the world a wider view of the universe.

WE HEAR that Einstein, who discovered relativity, has made Newton a back number, out of date and obsolete. Nevertheless the universe still proceeds according to the days' time table devised by the English mathematician. Einstein himself concedes that the laws of his predecessor continue to have a practical validity. Planets yet swing in their orderly paths and are spaced with relation to their fellow planets and their suns by the rules of mass, motion and gravity as laid down by Newton. Doubtless Einstein has found new truths. They do not cancel but extend the old ones.

Despite the popular idea, Newton was not the first to discover gravitation nor to find its exact law. Why then do we honor him? The answer is given by Dr. Paul R. Heyl of the U. S. Bureau of Standards:

"Newton stood head and shoulders above his contemporaries because he had vision, a broad mental grasp. Scientific knowledge before his day consisted chiefly of isolated facts. . . . But Newton was able to visualize all the moving bodies in the universe from comets to falling apples, and to demonstrate that they all obeyed a single law—universal gravitation. He brought order out of chaos; he had constructive talent; he was a builder."

No book as epoch-making as Newton's "Principia" appeared until Darwin's "Origin of Species" was published in the middle of the last century. The first book dealt with physics, or matter, and the second with biology, or life.

Today the "Principia" is taken for granted, the picture of the universe set forth in it is part of our common heritage, almost innate.

Some reader may wish me to clarify further the seeming contradiction between Newton's greatness and his stated lack of originality. Let us put it thus: Others guessed, he proved. Others collected bits of knowledge mingled with error, he selected the elements of truth and assembled them into a mighty edifice.

AT THE age of twelve Isaac Newton stood near the bottom of his class in public school. One day another boy gave him a kick on the stomach, which occasioned a great deal of pain." Thus was the most salutary and useful kick in history. It woke up Isaac completely and was the turning point in his career. He saw more red than he ever discovered later in the spectrum, pummeled his assailant to a standstill and as a real fighter took him by the ears and rubbed his face against the churchyard wall. Isaac's chest expanded. Then he realized that the boy he had whipped stood above him in school. This would not do. He resolved to win a mental as well as physical victory over his foe. He began to study and earned first place in school.

At home Isaac had a kit of tools and amused himself building models. One of these was a windmill like a big one in the neighborhood. To make the windmill perform inside the house, the boy inventor rigged up a treadwheel on which he installed a mouse, which was lured to travel forward by a bait of grain hung just beyond its reach. Isaac also made a water clock. This was framed in an old box and stood four feet high.

THE dripping of water on paddles or the like was the motive force and caused the dial hands to register. The boy kept the device in his bedroom and gave it a day's allowance of water every morning. It was such a practical clock that everyone in the house kept time by it.

As an improvement on the water clock, Isaac turned to sundials. The first ones

were based on rough observation of where shadows fell on house walls and roof at different times of the day. Wooden pegs were placed "to mark by their shadows the hours and half hours." With increasing knowledge and skill, the youngster produced more accurate sundials. He carved two of them on the masonry walls of his home, and it was said the neighbors came around to ascertain the correct time by what was known as "Isaac's Dial."

THE reader and I may smile over this ancient crudeness; we have clocks and watches galore and the daily check-up of radio time from Washington. Yet on second thought we get our time from Isaac Newton as did his neighbors. That radio time signal is merely the transit moment of a star whose apparent movement follows Newtonian law

Young Isaac made a horseless carriage which was propelled by the power of the occupant. Lacking smooth roads and ball bearings, this ancestor of modern vehicles had no chance. There was better luck with the manufacture of paper kites. Somehow the boy knew how to figure the proper shapes of kites and where best to attach the strings. By hooking a paper lantern containing a lighted candle to the tail of a kite which he launched at night, Isaac scared the country people into thinking they saw another comet, which was supposed to portend disaster

There was the gentle pastime of making doll furniture, as tables and cupboards, for girl friends. No doubt this furniture was done to scale. One of the girls, a Miss Storey, might have become Mrs. Newton if the young man had been financially able to marry. While in the period of catering to the dolls or girls, whichever it was, Isaac wrote verses and drew diagrams and pictures which he colored and framed to decorate his room.

Sir Isaac Newton, from an old portrait. "It seem to have been only like a boy playing on the seashore while the great ocean of truth lay all undiscovered before me"

The verses were probably a total loss. Crude pictures painted in optimistic colors Diagrams were the essence of childish work

Isaac's father had died before he was born. Many times thought the boy had the makings of a farmer but when he showed no interest in agriculture, brightened up in school, and was found one day doing a mathematical problem under a hedge, they decided to further his education. Around nineteen he entered Cambridge University. At a village fair he bought a book on astrology, and in order to understand this dubious but popular matter of astronomy he saw that he needed more mathematics. So he invested in a copy of Euclid. And like many youngsters before and since, he felt that the father of geometry dealt in self-evident kindergarten truths and tossed Euclid away "as a trifling book." Newton then proceeded to bog himself in the advanced geometry of Descartes. At length he realized that kindergarten truths were the necessary foundations of knowledge, went back to Euclid and from that time made more orderly progress.

As with other geniuses, the germs of great discovery came to Newton when he was young, a college student in the early twenties. He then invented the mathematical method of fluxions or calculus, analyzed white light into the rays of the spectrum and had his first glimpse of the law of gravitation. It was probably in the autumn of 1665, when Newton was twenty-three, "that the apple is said to have fallen from the tree at Woolsthorpe, and suggested to Newton the idea of gravity." Voltaire had the apple story from the favorite niece of the great mathematician, and we might as well believe it

When sitting alone in the garden and speculating on the power of gravity," writes Sir David Brewster Newton's

A letter written by Newton from Trinity College, Cambridge, at the age of forty, describing his studies of the theory of vision

biographer, "it occurred to him (Newton) that as the same power by which the apple fell to the ground was not sensibly diminished at the greatest distance from the center of the earth to which we can reach . . . it might extend to the moon and retain her in her orbit, in the same manner as it bends into a curve a stone or a cannon ball, when projected in a straight line from the surface of the earth

"IF THE moon was thus kept in her orbit by gravitation to the earth . . . it was equally probable, he thought, that the planets were kept in their orbits by gravitating towards the sun. Kepler had discovered the great law of the planetary motions, that the squares of their periodic times were as the cubes of their distances from the sun, and hence Newton drew the important conclusion that the force of gravity or attraction by which the planets were retained in their orbits, varied as the square of their distances from the sun.

"Knowing the force of gravity at the earth's surface, he was, therefore, led to compare it with the force exhibited in the actual motion of the moon in a circular orbit, but having assumed the distance of the moon at a certain figure, he found that the force by which the moon was drawn from its rectilineal path in a second of time was only 13.9 feet, whereas at the surface of the earth it was 16.1 in a second."

(Continued on page 133)

The discovery of the spectrum. Newton let sunlight pass through a hole in the window shutter and then through a glass prism, thus separating the white light into its color elements

The professor, tears streaming down his cheeks, knelt beside the girl. And there, under the moon, the strange story tumbled out in broken English, while Judy bathed Margaret's face

The Movie Maker

A Close-Up of Mechanical Magic Behind the Screen Revealed in This Romance of Courage and Ingenuity

By S. W. NEWMEYER

Illustrated by Ernest Fuhr

DON KENNEDY, red-headed young director of the comedy section of Popular Players' West Coast Studio, and Judy Burke, his script girl, shared the high ambition of some day producing a big feature picture. Toward this goal Judy had written an excellent scenario, while Don had invented a new photographic process by which action photographed in a studio might be superimposed on backgrounds taken anywhere in the world, thus effecting enormous economies in production. Jacob Eckstein, president of Popular Players, had promised Don his chance, but just when the young director's hopes seemed about to be realized, they were dashed by news that Popular Players was forced to suspend operations because of financial difficulties. The trouble was due to enormous expenses incurred by the famous but temperamental director, Carleton in filming a gigantic historical spectacle in the Orient. Eckstein, however, offered to turn the "lot" over to Don for six months, rent free—provided he would assume also the high-salary contract of Margaret Moreland, a beautiful but fading screen star. Though Don had only a few dollars to his name, he accepted. It was a wild gamble against big odds. Judy offered her scenario and her services without pay; then induced her brother Jerry, a stunt flyer, to join them. That night the three young partners attended the first performance of Margaret Moreland's latest picture, "Frozen Hearts." With them was Professor Mahrlenburg, an eccentric old photographer whom Don had befriended, and whose admiration for Margaret Moreland amounted almost to a passion. The picture was a failure—a pitiful anticlimax to the screen star's brilliant career. The show ended, they saw the star, in disgrace, hurry from the theater and speed away in her sport roadster. Suspicious of her manner, they followed in Jerry's car—out into the country at breakneck speed. At last, near the crest of a hill, Margaret pulled to the side of the road and stopped. Still following, they found her standing on the edge of a declivity. She raised her right arm. Steel gleamed in the moonlight. Jerry leaped from the edge of the road and flung himself upon her. A shot, a spurt of flame, and the two struggling figures plunged forward. Now read on

THE girl, fighting so desperately for death, became a limp weight in Jerry's arms as the fence ripped loose and they toppled forward. With the instinct of an airman, Jerry threw himself and his burden into a side-slip, and they shot along the dirt at the edge of the precipice. As they rocked on the edge, Jerry struggling to turn the balance to safety, strong arms pulled them to the road.

Jerry sat up as Don knelt beside them, but Margaret lay motionless on the road.

"Dead?" gasped Don.

Before the white background rode Jerry and Margaret, in medieval garb. Don took his place at the camera man's elbow. "Ready—action!" he called through the megaphone to the two

"Not so you'd notice it!" Jerry rubbed his aching side "Only fainted. I knocked the gun out of her hand just as she fired. Better tie her up before she comes to. She's got the manners of a wildcat."

In spite of his remarks, however, he was gently shifting Margaret to a more comfortable position, with Don's aid, when both men were pushed aside and the professor, tears streaming down his cheeks, knelt beside the unconscious girl.

And there, under the cold moon, the strange story tumbled out in broken English, while Judy bathed Margaret's face with water from the radiator of her car.

THE thousand-dollar-a-week star was the daughter of the penniless old professor! A runaway at sixteen from an English boarding school, Margaretha Mahrlenburg, self-christened Margaret Moreland, had refused to be forgiven and taken home like a naughty child when her father had found her in Hollywood two years later. As Don listened, he realized that only a near-tragedy could have brought those two together, so alike were they in their fierce pride

Jerry, who had disappeared down the road to get his car, now pulled it up beside them, and as Don helped the old man and his daughter into it, he felt sure the events of the night had dissolved their bitter stubbornness and reconciled them completely.

Certainly something had melted the almost haughty reserve for which Margaret Moreland was famous, for as Judy tucked the abandoned ermine cape around her, she leaned against her father, her body occasionally shaken by sobs she could not control. Judy settled herself on Margaret's other side and Jerry drove carefully away, leaving Don to follow in the big racer

Where the road widened, however, Don passed them, and when Jerry's car trundled into the drive of Margaret's home in Beverly Hills, he was waiting there for them, his arms loaded with small bundles.

"Tried to rouse someone," he told Margaret, "but they're sleeping like the dea—like logs," he finished hastily.

"There's no one in the house." Margaret stepped from the car, quiet and composed as usual, but with a new gentleness in her manner. "My servants are out."

"Well, I don't know how you folks feel," remarked Don heartily, "but I'm starved, so I went on to the delicatessen and got the makings of a Dutch lunch. How about some hot coffee and a bite to eat?"

Right-o!" Jerry took the key from Margaret's hand and sprang to the porch. He flung open the door with a flourish. "Opening the Moreland Cafeteria, ladies and gents. Line forms to your right."

Margaret stepped past him, snapping on the lights from room to room as she went through the house to the kitchen They trooped after her, Jerry and Don keeping up a stream of lively comments and would-be jokes, none of them very funny but all lending cheer to the coldly silent house.

Judy's eyes were too busy for her tongue to function She stared round-eyed at the beauty of Margaret's home—not large, but as exquisitely fitted and furnished as a jewel box Silk damask wall coverings, old rose in the living room, golden-brown in the library, dull blue in the dining room. The inlaid grand piano in the pale blue and gold music room, where Judy paused for a prolonged peek, must have cost twenty-five thousand dollars, she estimated

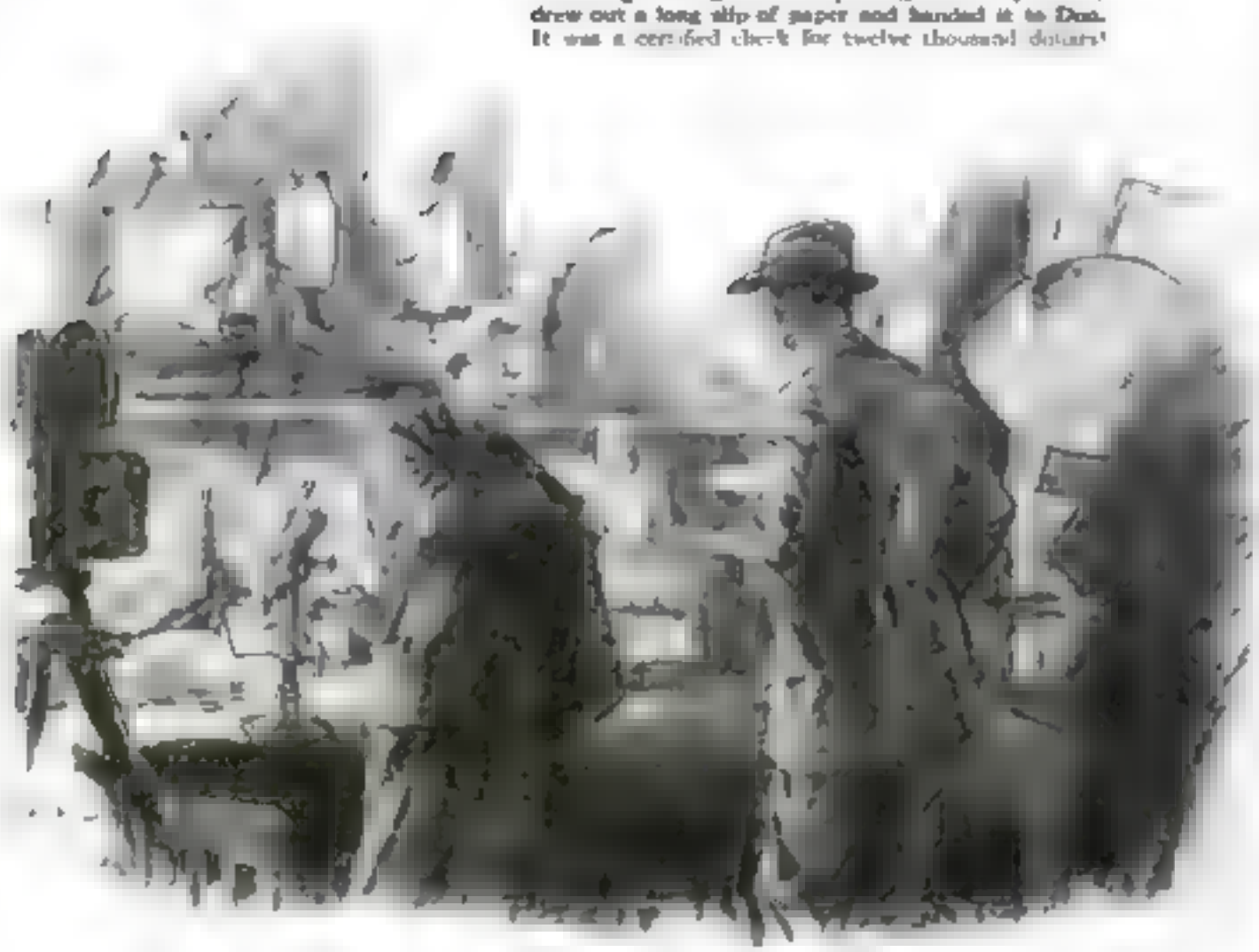
But the kitchen was a gay little place shining with Delft blue and white tiles, a porcelain clock like a Dutch plate ticking away on the wall. Margaret enveloped them all in voluminous white aprons and set them to work. Soon the appetizing fragrance of hot coffee mingled with the savory incense rising from a Welsh rarebit, and they all crowded around a small table in the breakfast alcove. As Margaret ladled out the thick yellow mixture, she looked up at the professor with a smile.

"FATHER, do you remember the marionette theater you made me one Christmas?"

"One of my happy memories, it is," he replied. "But I now have made you something finer—something that will astonish the critics when they see your next picture!"

Margaret shook her head slowly

"The critics—and my *dear* friends—will wait a long time before they see my next picture," she remarked in a low tone, "perhaps forever."



Fumbling at length in his pocket, the old professor drew out a long slip of paper and handed it to Don. It was a certified check for twelve thousand dollars!

"But no!" exclaimed her father. "Have they not notified you at the studio that Don—"

"Mr. Kennedy must know that I have no feeling against him as a director." Margaret looked across at Don with a friendly smile, "but I'm sure he will understand that I cannot allow my face to be used as a stop for custard pies—even if I am old and passé, as Eckstein told me this morning," she finished bitterly.

"Eckstein!" roared the old man, pounding the table. "What does he—"

"Let me explain." Don's voice was quiet, but it had a note of authority that silenced Professor Mahrenburg. "I want Miss Moreland to understand the entire situation before she decides."

Margaret listened attentively, though without enthusiasm, while Don outlined Eckstein's terms and conditions. But her attitude began to warm as, aided by Judy, he told her of the picture they had planned. When he spoke of the screens designed by the professor to make her look younger, Margaret flashed her father a grateful smile.

"And you have backers?" she asked Don as he finished.

"NO," HE replied frankly, "and I may not be able to find any. In fact, without you we have nothing at all but Judy's story and my invention. I don't even know, now, how I'm going to pay your first week's salary—so it might be more profitable for you to hold Eckstein to your present contract, even if you have to sue him."

Margaret looked down thoughtfully at the huge sapphire on her little finger.

"If I sue Eckstein," she said slowly, "he will drag the case through the courts, humiliate me—and I've had as much humiliation as I can stand. For months I've been taking powders to put me to sleep at night, but they've lost their effect. Night after night I've lain awake looking at my life, watching myself grow old, losing beauty, love, even respect. That is why tonight . . ." She paused, the shadow of terror in her eyes; then raised her head gallantly and looked at Don. "Tonight I thought I had nothing left that the world wanted, but if you need me in your picture, Mr. Kennedy, I'll donate this—" she drew from her finger the large sapphire ring and handed it to him, "and the amount of my salary to the venture."

Judy clapped her hands and Jerry waved his paper napkin with a mild hurray, but Don, usually the silent, serious member of any group, thumped the table with a large spoon and jumped to his feet.

"That calls for a speech," he declared. "Tonight I almost lost hope for the big picture, but now Miss Moreland's given it a fighting chance—and we'll fight, the five of us! We'll do things they say can't be done, and with just ourselves owning the picture, writing, directing, acting, selling it, we won't have to buck interference from higher-ups. It'll be like the old days of Biograph, twenty years ago, when Griffith himself acted, directed, cranked the camera, edited scenes, and wrote scenarios, when Mack Sennett carried the camera and played heavies—"

"MARY PICKFORD wrote scenarios, too," chimed in Judy, "and acted leads without her name on the program, and brought her family and friends in as extras. Jack and Lottie Pickford, the Gish girls, and—"

"And began giving the public what it wanted," interrupted Don, taking the floor again. "That's what we're going to do. Now, here's my scheme for starting the big picture."

It was dawn when the three men drove away in Jerry's old car, leaving Judy to finish the night, or rather the day, with Margaret. It had been agreed that all should work without salary, the amount due each to be charged against the picture and deducted from its first profits, the remaining profits to be split equally among them. From the money Jerry had planned to spend for his new airplane, he advanced Don a thousand dollars to pay his and the professor's living expenses during the making of the picture.

Now to raise the money for production expenses! Don estimated they would run well over a hundred thousand, in spite of the great economy his universal background device would make possible, for the picture was to be a super-special of the type that often means an outlay of close to a million dollars.

Sunday afternoon the group met again at Margaret's home. This time a sixth and very important individual was added to the conference. "Bozo" Biddle, camera man of the unit that had produced "Frozen Hearts." Bozo had been Carleton's first camera man until that temperamental director had picked an entirely new company to take across the Atlantic for his big historical picture. And as everyone on the lot was aware, Bozo was still sore because he had been rejected. He not only knew his lights and lenses, but all the queer corners and beauty spots of the world were charted in his memory, for he had been a newsreel photographer many years before being employed by Popular.

Bozo was the man Don had selected to take the camera on a jaunt through Europe and part of Asia to record the location on the reels, while the cast was to stay at home and do the acting against blank backgrounds and specially prepared sets. Then Don's universal background device would combine the two in to a big spectacle picture.

"All you've got to do," explained Don, "is to carry the camera, plenty of film, and a stop watch. Shoot three or four reels in England—an old Norman castle that looks pretty much as it did in the twelfth century, a few miles of English countryside without any modern landmarks, a river scene—anything that has ancient atmosphere. Give us plenty of long and medium shots and foregrounds, with a lot of detail such as moats, drawbridges, massive doorways, and old courtyards. And don't forget to take as many stills as possible, interiors especially. We'll need them for our scene painters."

"BUT what's the stop watch for?" asked Bozo, puzzled.

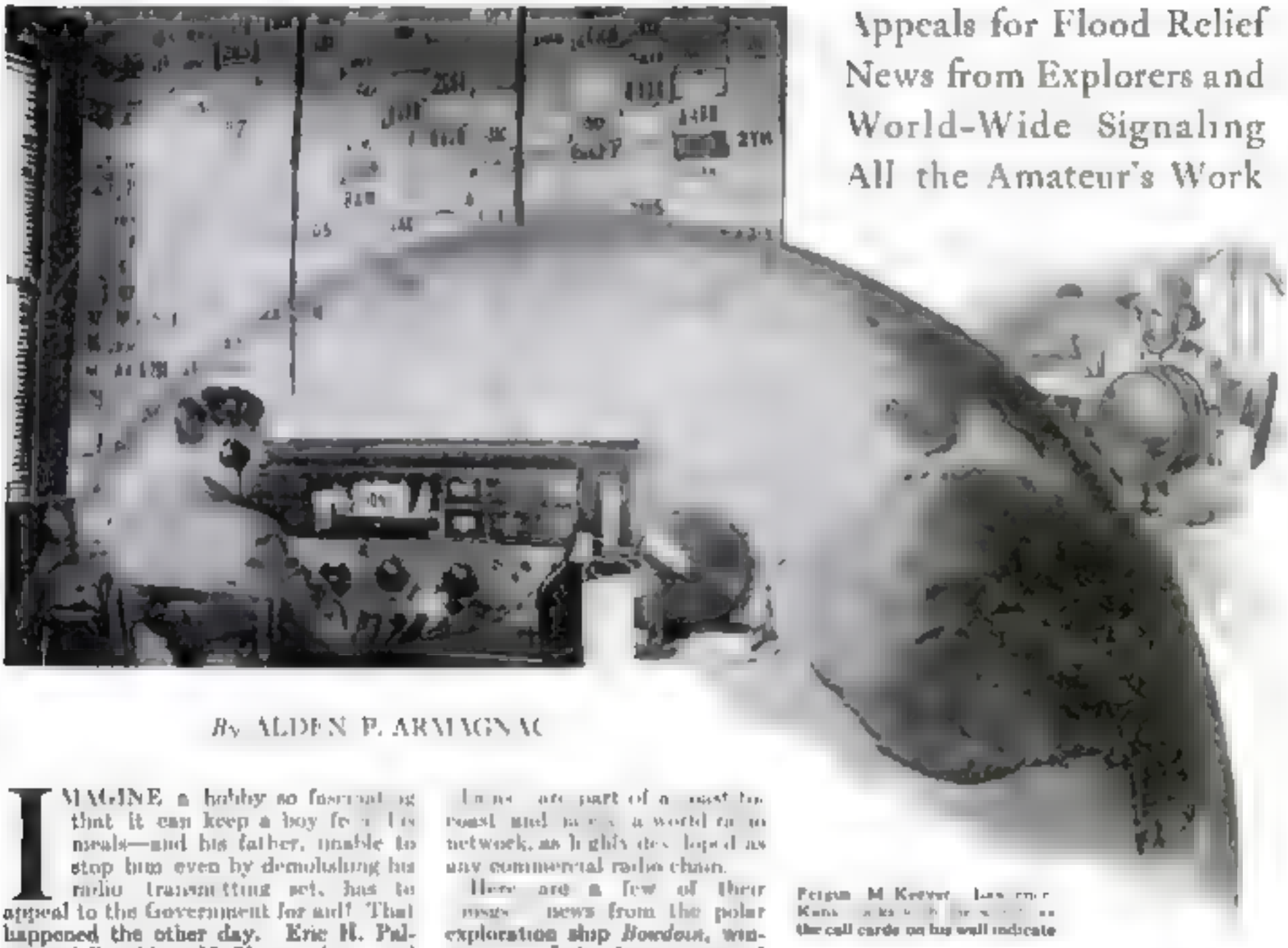
"To keep a record of the exact time you crank each shot, so I can duplicate it here on the lot," Don replied. "And be sure you inclose the time record with each reel."

Bozo was delighted with the assignment. At the railway station next noon Don met him with money for the trip, a detailed script of the scenario, and a long list of

(Continued on page 167)

Triumphs of Radio's "Hams"

Appeals for Flood Relief News from Explorers and World-Wide Signaling All the Amateur's Work



Fergus M Keever, [illegible] Kans., [illegible] the call cards on his wall indicate

By ALDEN P. ARMAGNAC

IMAGINE a hobby so fascinating that it can keep a boy from his meals—and his father, unable to stop him even by demolishing his radio transmitting set, has to appeal to the Government for aid! That happened the other day. Eric H. Palmer, of Brooklyn, N. Y., sat down and penned an urgent letter to the Federal Radio Commission at Washington, D. C.

"Please revoke my son's license to operate his amateur station 2ATZ," the father wrote. "I do not believe he has seen the sunlight in three months. He transmits all night, sleeps in the daytime, and eats but one meal a day. I believe the boy will die of undernourishment and lack of sleep, and his mother will fall the victim of a nervous breakdown."

Dots and dashes flashing through the ether this very moment are the conversation of sixteen thousand boys and men throughout the country. Like young Palmer, they have made amateur radio their hobby—if more temperately than he did, no less enthusiastically.

"HAMS" they call themselves. No tame evening spent before a loudspeaker satisfies them. After supper you will find one of them in his attic "radio shack," clicking the key of his homemade transmitter mounted on a desk-shelf beside the hissing radiator. His sleeves are rolled up, and head phones are clamped on his ears; as he presses his key he converses with a friend thousands of miles away. Call cards acknowledging the talks are exchanged.

Not every one knows that the radio [illegible] are part of a coast-to-coast and across-the-world radio network, as highly developed as any commercial radio chain.

Here are a few of their messages: news from the polar exploration ship *Bowdoin*, wintering at Labrador; an appeal for help from Vermont, stricken by flood; Army advices from Fort Monmouth, N. J.; an America-Europe conversation between two "hams," and incidental chats among the several thousand amateurs who were not already busy sending, receiving, and forwarding those messages.

THAT was the meaning of some of those dots and dashes you could have heard on Palmer's short wave length receiver, far below the waves of broadcasting stations. And so the Federal Radio Commission, while it suspended Eric Palmer, Jr.'s license for ninety days, told him in a letter:

"America is looking to its 16,000 amateur operators, in which group you stand out, to keep it in the foreground of development. Those of us who were pioneers will soon be forced to turn over the reins of radio to you boys, and we want you to be strong and healthy, as the burdens will undoubtedly increase as new avenues for radio are opened by you and your colleagues. This is a marvelous field for the American boy, and such enthusiasm as you have displayed should as a rule be commended rather than discouraged, but in order to develop into a big, strong, healthy boy you must have regular meals and your full quota of sleep."

What part do amateurs play in radio? Independently of all commercial stations, they link the United States and most of the world. They will gladly transmit for you, without charge, a message to anyone, anywhere. They keep newspapers informed of what is happening in isolated places, promote world fellowship by the friendly interchange of messages between continents, and by experiment constantly raise the art and science of radio above the high point where they have already largely helped to place it.

WIRES were down in Vermont, not long ago. Through the crackling static flashed a sputtering CQ—"anybody answer."

Arthur Kent, at Binghamton, N. Y., spun his dials by chance to forty meters. "CQ," came a faint call and Kent seized his key. "8BTO standing by," he shot back. "Go ahead."

In a whir of dots and dashes, from Ralph Harris, 1BEB, came the first direct news out of Montpelier, Vt., since the flood hit it—of people marooned on the roofs of houses, Lieut.-Governor Jackson dead in Barre, bridges, roads, rails washed out. 8BTO acknowledged message after message, some for help and others to relieve anxiety of relatives,

until one o'clock in the morning, when Harris sent, "You are my only contact out of this city. Power off, electric light plant under water. Using amateur batteries. Done all we can. Good-by." His messages, forwarded to Washington, set in motion the agencies that brought relief to the stricken area.

Another amateur, at station 1HDX, flashed the first direct news from Barre, Vt., another, in Connecticut, put service only when the water was coming over the top of his table. When city power failed, some amateurs sputtered away with motor car spark coils. A Vermont amateur's signals weakened, then came back as 2CVQ, New York City amateur copied them. "Just kicked the batteries out of water on to dry place," was the laconic explanation. The Army Signal Corps is compiling the names of amateurs who will be officially commended for the part they played in the crisis.

This amateur station looks crude enough in comparison with that above, but with such apparatus radio "hams" have girdled the earth

IN BLIZZARDS, when railroad trains are stalled and wires down, the radio amateur gets the message through to the dispatcher's office. A special radio call, "QRR," is the railroad SOS.

When a tornado raged down on Murphysboro, Ill., an emergency call appealed to C. B. Harrison, operator of the only radio transmitter near by. Up into the forbidden wave channels of broadcasting stations the amateur tuned his wave. Every listener heard a ghostly voice break into the evening program giving news of the calamity and urging doctors and nurses to board a relief train on its way to the stricken town. How that train, jammed with workers, brought relief to stricken Murphysboro is now history.

During the ill-fated Dole flights from California to Honolulu last summer an amateur "tie-up" of local stations flashed last minute news between Hawaii and the mainland. And through the modern miracle of the "hams" short waves he has rendered a service that is exclusively his—keeping the world in touch with explorers.

Donald Cadzow, ethnologist of the Putnam Baffin Island Expedition on the schooner *Bowdoin*, flashed a radiogram from polar seas to amateur station 8DNE, Auburn, N. Y., to give the first news of Arctic discoveries that change the map of North America. "Personal messages from home," the explorer said, "were flashed over the mountains and ice fields to the expedition by Charles Heiser's radio station, Auburn, in an uncanny way, when even the greatest stations of the country could not be heard." They gave the explorers the novel experience of reporting their discoveries minute by minute and receiving radioed congratulations from home. What a contrast to the old days of months-long treks with dog teams to carry news to the nearest outpost!

Thousands of personal messages are sped on their way over the "hams" carefully worked out "traffic routes" through stations all over the country.

THEIR call letters, such as 1BEB and 8DNE, are assigned by the Supervisor of Licenses. The number that precedes the radio call letters designates in which of the nine radio districts of the country the amateur station is operating.

In national emergency, such as war, the "hams" will instantly place themselves at the disposal of the Government with a reserve communication chain of inestimable importance. The Navy Department has disclosed plans to organize expert amateurs of the Eastern district for training in handling Navy messages. In a year the Army, which [illegible] amateurs 13,000 messages [illegible] Fort Monmouth, N. J. [illegible] N. J. recently.

The world is a little too small for some amateurs, and "ham" William C. McKay, distinguished New York mural painter, converses regularly with a friend in Cape Town, South Africa. G. F. Cassle, of Paterson, N. J., recently picked up a message from Liberia and, notifying the U. S. Department of State, sent back its official greetings. Many American "hams" belong to the "WAC Club," composed of those who have "worked" all continents.

Let your mind wander back to July, 1914, when the boy fortunate enough to have a "wireless set" commanded awe from his acquaintances, and no one dreamed that more than 3000 new amateurs a year would be applying for licenses by 1928.

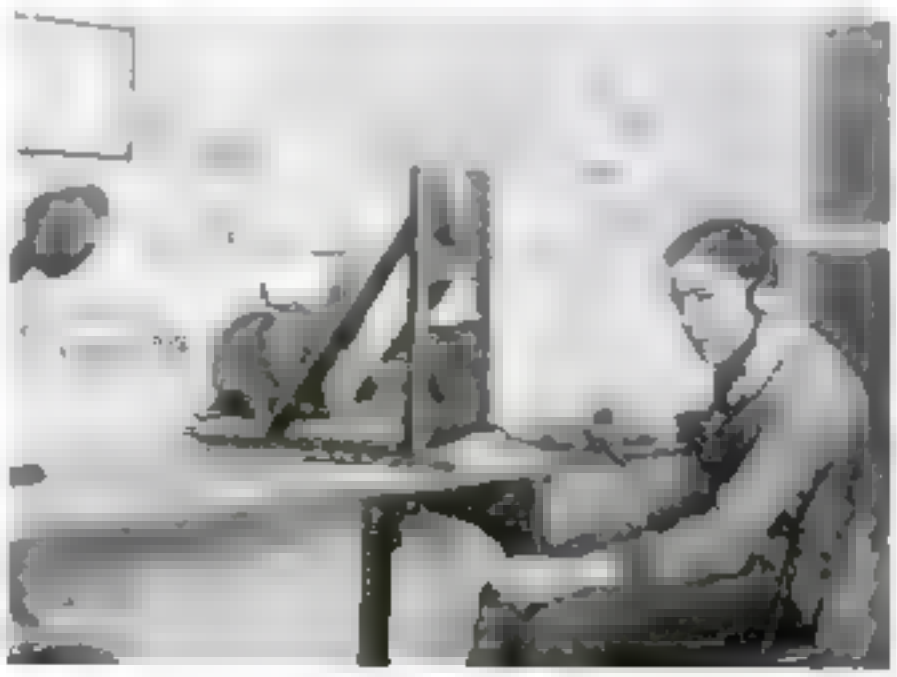
THAT month came an important announcement. The American Radio Relay League was being organized under the auspices of the Hartford, Conn., Radio Club. This league, now the backbone of organized amateur radio, directed the entire series of epoch-making tests that led to trans-Atlantic amateur radio and greater conquests.

Wireless fans rushed to join the League, and before long a new language had sprung up—a curious, abbreviated code. You might be puzzled by this sample:

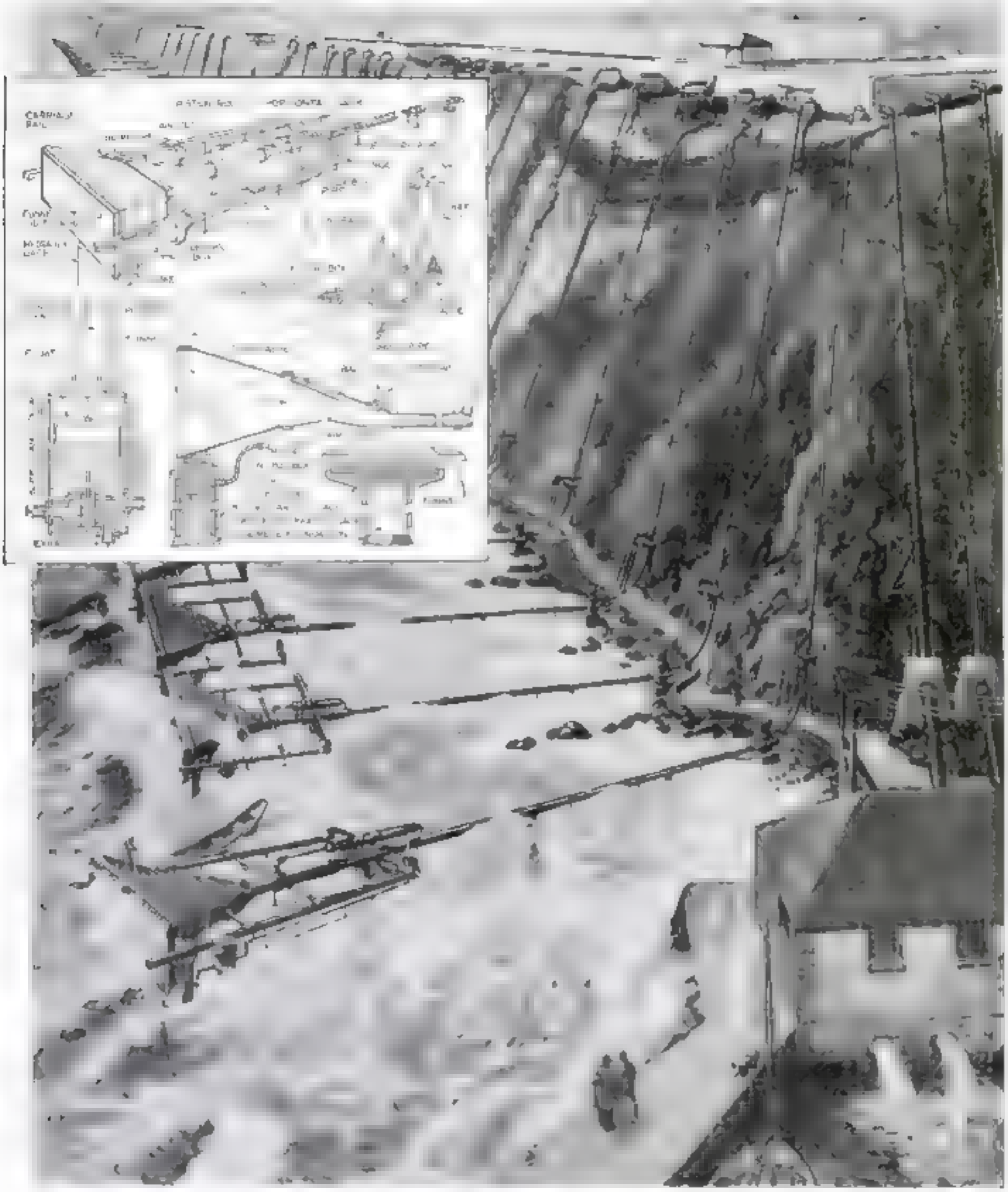
"Ur sga QSA OM fb. hw do u lik mi spk? . . . tt's gd cuming fm u . . . sounds lik mi YL singing hi C . . . hi . . . sa couldn't u drop in sm nite cs wk stn DX wit me? tonite? . . . cul . . . best 73's."

When translated this becomes:

"Your signals are coming in strong here on main line business. How do like my spark? That's good coming from you—sounds like my young lady friend singing high C (laugh). Say, couldn't you drop in some night and talk to some distant stations with me?" (Continued on page 141)



Eric R. Palmer, Jr., Brooklyn, N. Y., boy amateur radio operator whose license was suspended for 90 days so he could get some sleep and meals



Sea Waves to Drive Novel Power Plant

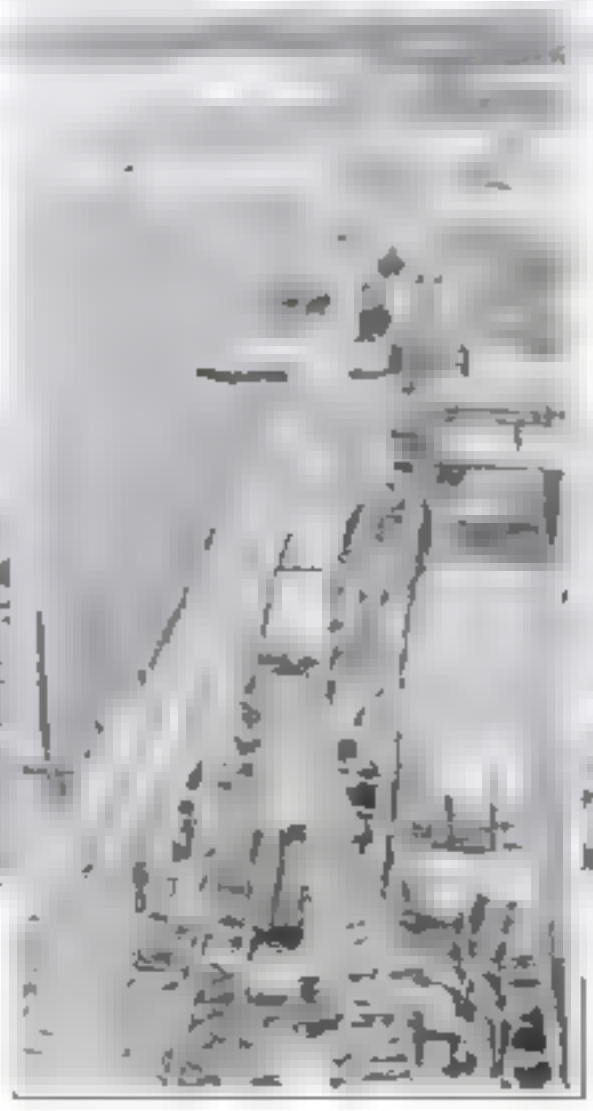
TO LET the ocean waves do the work of man by providing hydroelectric power, Lieutenant Commander Lybrand Smith, of the Navy Department's Bureau of Engineering, has designed an amazingly ingenious battery of hydraulic rams, illustrated by this schematic drawing and the accompanying diagram.

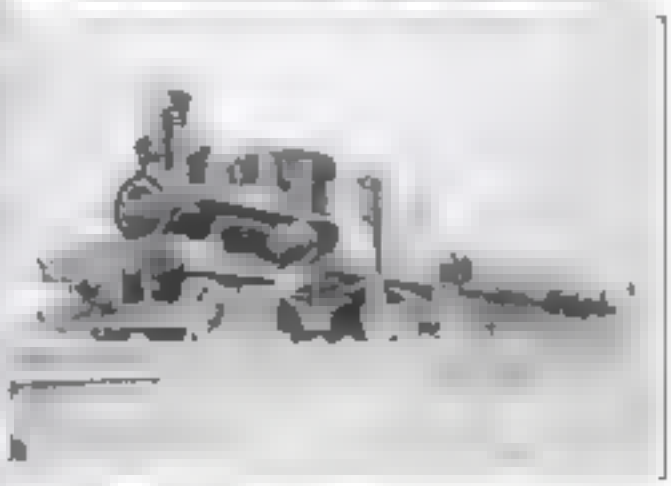
The drive of the waves into the great funnels forces the water through pipes up the cliff into the long flume along the edge of the cliff. This flume carries the water into the reservoir, from which the accumulated water pours down larger pipes with sufficient force to operate the generating machinery in the power house below.

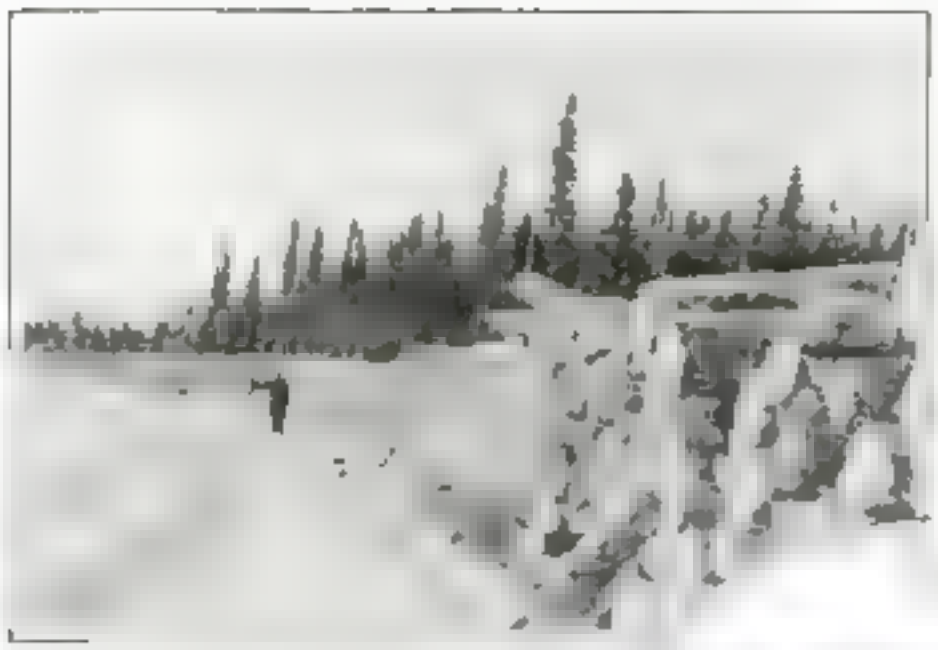
The hydraulic rams operate hydraulic jacks which are simply valves so arranged that the water forced into them by each successive wave does not fall back when the wave's strength is spent but is locked in to remain until more water is forced in by the next wave. Each valve, like a door that opens but one way, is pushed open by the water's force. When the force is exhausted the weight of the water closes the valve, holding it shut until the next wave presses hard enough to open it.

The World's Greatest Timber Crop

Amazing Machines Help Glean 150,000 Cords a Year on Strange Island

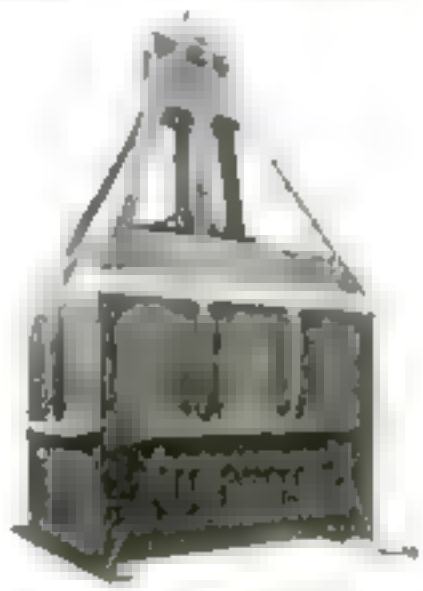






Through winter almost [illegible] mile mass of pulpwood [illegible] on the snow along rail [illegible] transports [illegible] Mercier in the [illegible] Dots in the huge [illegible] by Henry Mercier, French [illegible]

Cape Observation in Anticosti. The [illegible] gives one a fine view of the [illegible] of the piers [illegible]

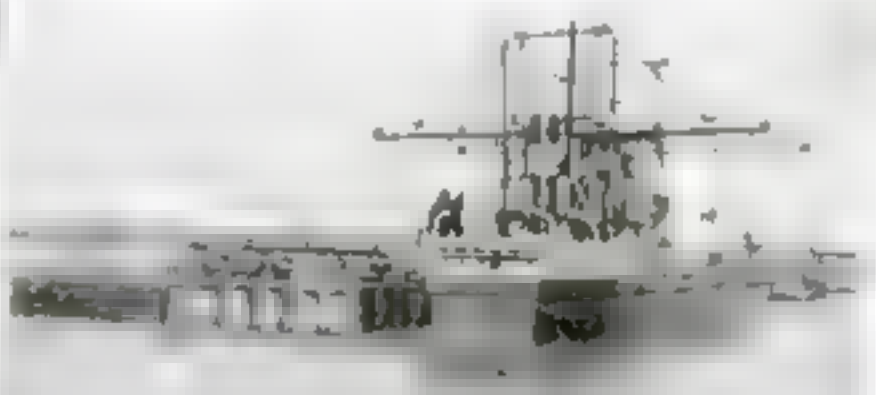


Map showing Anticosti's [illegible]

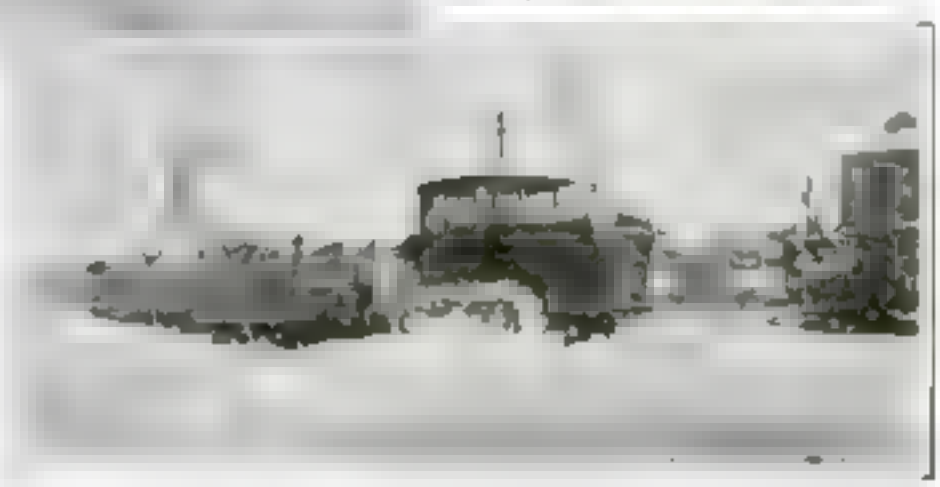
ON THE little forest-covered island of Anticosti [illegible] the largest [illegible] operations in the world [illegible] of pulpwood a year to [illegible]

These pictures give an idea of the huge [illegible] to develop [illegible] with locomotives and rolling stock. The [illegible] includes a fleet of caterpillar tractors [illegible] "alligator boats" for use on land or water [illegible]

Above and [illegible] views [illegible] mile [illegible] pulpwood [illegible] 4 miles [illegible] from 50 [illegible] built [illegible] They work night and day when [illegible] for the [illegible]



[illegible] pulpwood [illegible] 4 [illegible] the [illegible]



Unusually built pier at Port Mercier, where work goes on the year round to improve and extend facilities to harvest the 12,000,000 or 15,000,000 cords of pulpwood and one of the island's peculiar ships used for this work

One of the powerful caterpillar tractors that haul trains of sleds loaded with pulpwood through the snows of Anticosti. These machines make it possible to do some harvesting of the wood even during the winter time

One of the battleship 9s on wheels with its crew, photographed after its assembling at St Nazaire, France, just before it left for the front to hurl 1400 pound shells

Our Battleships on Wheels

How American Navy, Firing "Off the Map" Shattered and Set Aflame Germany's Vital Rail Centers, Hastening Victory

By REAR ADMIRAL CHARLES P. PLUNKETT, U. S. N.

In Collaboration with THOMAS M. JOHNSON

In this, the third and final part of the amazing story of the American Navy's long-range guns that helped turn the tide of World War battle against the German, Admiral Plunkett, who commanded the guns, and Mr. Johnson, who as a war correspondent watched their campaign, reach a smashing climax.

ON THE war map you stuck pins in ten years ago, Laon was northeast of Soissons, with so many radiating railroads that it looked like a spider. Gun No. 1 cut off the spider's legs at eight days' bombardment, though news came at the end of the first day that the German retreat from before Laon was commencing.

That was September 28, and we had just given the Germans a continuous performance from 1400 until 5:30 in the afternoon. We only stopped then because it was dark and they could easily locate us by the great flash the gun made. We had dropped forty-seven fourteen-inch shells at 34,320 yards on their railroad subngs about one every six minutes. On September 30 we commenced at 11:57, fired five shots, knocked off for dinner, and between 2:36 and 5:27 fired twenty-five more. Enemy airplanes came over, looking for our exact position.

NO WONDER. Nothing so big as our shells had ever before burst in their midst.

On October 1 the Germans threw more shells into St. Christophe cemetery. We squared up next day by dropping thirty on the Laon west railroad.

We had hooked up our telephone to a French sausage balloon and on October 3 we began firing with airplane observation. We fired ten shots, and the observer saw six land, two on the military railroad we were after. We knew that meant a tie-up on the subway for the Germans, so at 5:30 we knocked off, having thrown nine more shells after correction by the observer's reports. Next morning German shells landed between us and Soissons. We sent the ammunition cars into safe retirement.

ON OCTOBER 5 the Germans cracked down on us hot and heavy in the afternoon, and again in the evening. One shell struck sixteen feet from the gun, and fragments cut the train air line and broke off a piece of casting. One struck a clothes bucket in which a gob had been doing his washing. We sent the men back out of danger and moved the gun back. The Germans, unaware, opened up again in the evening on our old position.

The total damage was nil, but next time we might not be so lucky. We dug holes for ourselves, and made dugouts near the gun to hold fifty men.

Our battleships on wheels drew a lot of attention. Allied officers were continually inspecting them and military visitors bothered our firing until we had to build a rope fence around the gun. American Congressmen visited us, and one wrote his name on a shell before it was fired. Our most delightful and delighted visitors were French and American nurses from a hospital at Villers-Cotterets that the Germans were bombing, who came to see us get even.

OUR two guns fired every clear day and some that weren't. Gun 1 on the Laon railroads, Gun 2 on Mortiers, until at dinner time October 12 the French sent word their infantry were entering Laon. To see the effect of our shelling, Ensign Roger Allen and I followed on October 14.

It was easy to tell where our shells had hit. No other shell holes were so large and deep as ours, which averaged forty to seventy feet across, and in some we found fragments that we recognized. We found the nose of one shell three miles from where the shell had exploded. One hit was enough to wreck a three-track railroad line for at least 100 feet, blowing an enormous crater in the roadbed. Although the Germans had repaired the damage at night, their use of the railroads had been greatly curtailed. A freight train was on a siding just as it

had been struck, one car thrown on top of another, a third thrown thirty feet. Three shells had wrecked completely a storehouse used for electrical material.

The French people told us that the Germans had a large moving picture theater in Laon, always crowded with soldiers. One shell struck it. Forty Germans were killed and sixty severely wounded.

We found that when we had fired "off the map," shots were almost always effective hits, but where we had airplane observation and applied corrections, later shots were perfectly placed. We had airplane observation on only about ten percent of the 782 shots we fired in France. The fall of only twenty-three of Gun 1's 198 shots could be observed many more shots called "unobserved" were fired following corrections and these were usually direct hits.

SHORTAGE of aircraft or necessity of firing on cloudy days were the usual reasons for firing off the map. And an observation aviator up 5000 or 6000 feet had his troubles. Not only did German antiaircraft artillery and fighting planes make special effort to get him, but often on a seemingly clear day a ground mist made it impossible for him to see shell bursts. One French aviator worked against a sixty-mile gale that blew him over the German lines and had a hand and his face frozen.

Rear Admiral Charles P. Plunkett, commander of the American Navy's famous battleships on wheels

Longuyon, vital center of German strategic railroads, which was demolished by shells fired from U. S. Naval guns 23 miles away in the critical period of Meuse Argonne battle. Photo shows Americans moving in after the Armistice

Firing off the map is not hard for anyone who has been a navigator. We considered the problem a dead reckoning course and distance calculation. We used only a map showing the vicinity of the gun position and another showing that of the target position.

TO OVERCOME the difficulty of representing a spherical surface like the earth on such maps a projection called the "Lambert projection" was used to give a correction applied to astronomical observations of sun or stars or of polaris by theodolite, to obtain a "Lambert bearing"; by this a traverse could be run over the gun sight to orient the gun according to the Lambert system. You wouldn't think you would have to take solar observations before you could shoot up Germans sounds like astrology.

Another curious thing about our battleship on wheels was that we got weather reports radioed frequently from stations along the front. These gave us route barometric pressure, temperature, force of ballistic wind, its direction, and height of observing station. They got wind direction by watching small free balloons rise and drift. At night the balloons were loaded with powder, set to explode at different heights, and their positions in the air determined by sound ranging. That is one of many illustrations of the complicated and scientific procedure of firing long range guns.

Of course, to fire a 1400-pound shell as far as 48,000 yards at something you can't see, going up 33,000 feet into atmosphere conditions that must be largely guessed, is a real task. But miraculously,

One of the dugouts that sheltered American gobs in France from the answering shells of the Germans while the Americans were wrecking enemy railroads with the biggest guns that France had ever seen on land. This artillery duel lasted more than a month, when the war ended

we found the range error averaged only 151 yards and the deflection error only fifty-one, and, as most of our targets, such as railroad yards and ammunition dumps, were of great extent, and as one gun fired as many as fifty shots in one day, we believed we had worked out a method of scattering shots so as to do the greatest possible damage. Commander Schuyler has suggested that a mathematician might discover how long-range guns without observation can do the greatest damage. That would be worth knowing in the next war.

In the last one we marked off about 400 meters beyond the near edge and 400 before the far edge of the target, then drew lines 200 meters inside the right and left edges. Within that area we drew a series of circles which we marked with a point for each shot to be fired, pointing them in the order in which we would concentrate each shot to take out one of these points. It worked so well that General Mangin was well pleased.

The headquarters of this celebrated French general were only a few hundred yards from one of our gun positions. Once I was at dinner there when an orderly brought a note and the General and his Chief of Staff went into the next room where the maps were. When they returned, the General remarked:

"Well, Admiral, you have been making a good deal of noise with your guns. Now it is my turn to make some."

In a minute or two there was a deafening crash as every French gun for miles, it seemed, burst into action. For perhaps a half hour they fired continuously, the general meantime talking on about other things. He only nodded when a second note told him a strong German counter-attack had been repulsed.

AS SOON as General Pershing heard that we had definitely succeeded, he sent for us to help win the biggest battle in American history and the last days of October saw our highest ambition realized—all five of our battleships on wheels assembled in a "fleet" under immediate command of myself, an American admiral, working with the American Army to win the war. Another proof that we had made good was an order to the Navy designers in Washington to commence planning a new gun car, using the lessons we had learned, to carry a second "fleet" of five guns to France. Before they got there the war was over.

Our guns were in at the death. Under the hammer blows of all the Allied armies, the Germans were retreating slowly from Belgium and Northern France. The pivot of their retreat was the Meuse-Argonne region north of Verdun, where the Americans were attacking. Here General Pershing was trying to reach a web of railroads of vital importance to all the German armies.

These lines connected the Rhine and Germany with the front in France by way of Metz, Montmedy and Sedan, all big railroad depots. Montmedy had a large railroad yard usually filled with cars. It was on the main line from Metz to Sedan. It was headquarters of the German Seventh Army. All the railroads in the locality were part of the German solar plexus and you couldn't cut one without making trouble for all. Our secret field orders from Brigadier General William Chamberlaine, the American heavy artillery commander, said:

"The towns of Montmedy, Longuyon, Spincourt and Conflans-en-Jarny are among the most important railroad centers of the enemy's transportation system for the supply of the Western Front.

"A GROUP of long-range guns more powerful than heretofore assembled for a single operation is now being emplaced to attack the above centers."

So we started out to do it. The place selected was the nearest point on the front to Longuyon and Montmedy, where they had built the curved tracks from which our guns fired. At Thierville, two miles northwest of Verdun and at Charny, three miles north of Thierville, both rather hidden among the heights of the Meuse, were our positions.

The first guns to get there and join the American Army in battle were Numbers 1, 4 and 5, which came up from Haussimont without many Jonahs for their first trip to any front. Pits were dug at Thierville and Charny for guns 1 and 2, en route.

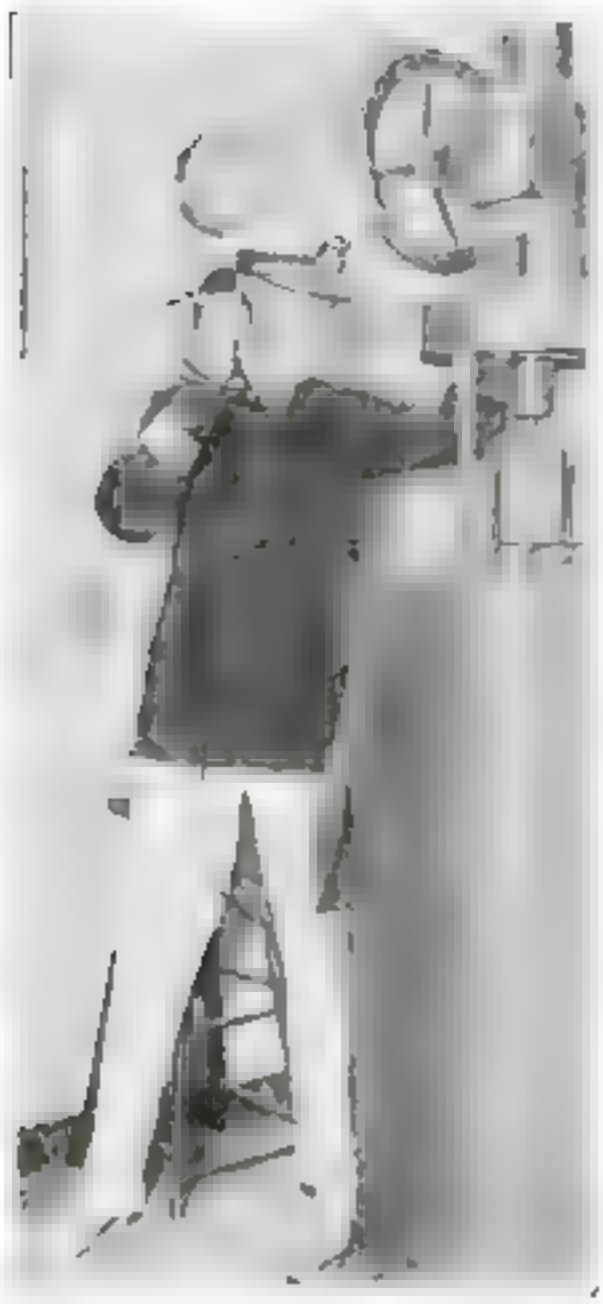
The same day that I was counting the big holes Gun 1 had made around Laon, Guns 3, 4 and 5 were digging their pits at Thierville, nearly 100 miles southeast. A couple of days later the Germans gave the village such a shelling that Lieut. J. R. Hayden took fifty cans of powder in out of the wet and put them in a bombproof.

At 12:22 on October 21 Gun 3 fired the first shot, and just one hour later six German airplanes were flying overhead, and about 4:30 seven shells fell near the gun.

On October 23 Guns 4 and 5 fired one shot each, ranging on Longuyon at about 38,500 yards, and (Continued on page 153)

Top photograph: One of the American naval guns that helped make German retreat almost a rout, wrecking railroads, ammunition stores and headquarters. Middle: Pit and foundation under gun that permitted maximum elevation and range of 42,000 yards with old shells, nearly 50,000 with new which never reached France. Bottom: loading ammunition car. Drawings show a berthing car and the shattering of a train

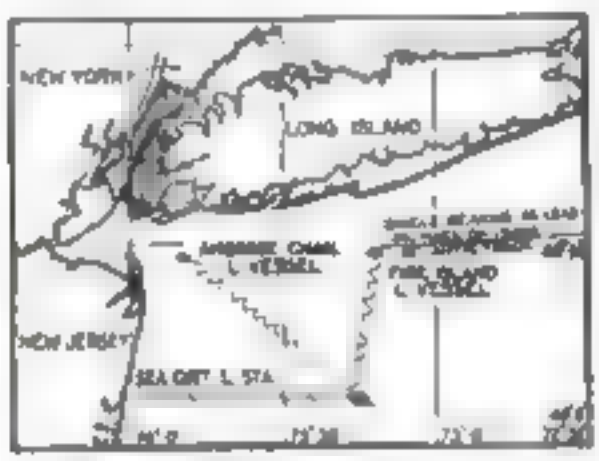
Robbing Fog of Its Perils



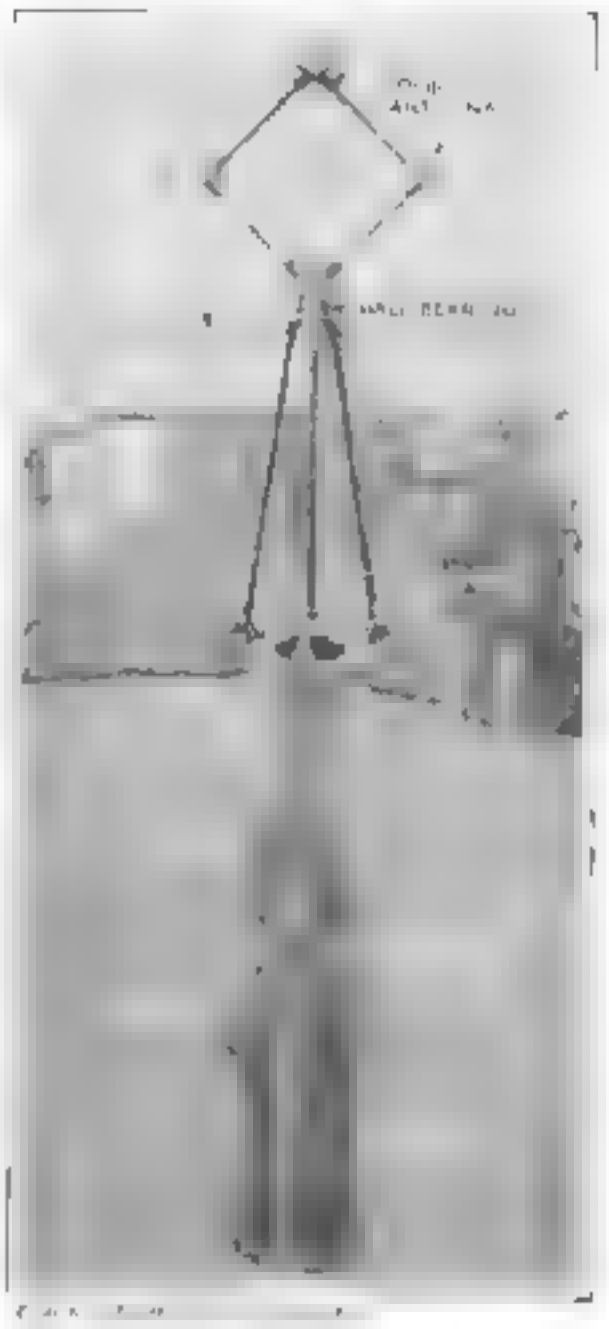
Commodore Hartley, *Leviathan's* master, taking bearings with radio compass. He rotates the antenna loop above deck until signals from the beacon are weakest. Then the indicating device shows ship's exact position

Waves of Radio and of Light and Sound Guide Planes and Steamships Through Blinding Vapor

By
NORMAN C. McLOUD



Exchange of radio signals by liners with light ship and light station and with each other show their positions and guide them into port



The "ears" of the radio compass—the ball bearing rotatable loop antenna mounted on deck and controlled from the pilot house by a shaft. The loop consists of a number of turns of wire inclosed in water tight tubes

WE WERE nearing the American coast in a fog which had blanketed us a good part of the way across the Atlantic. For three days our ship had barely crept, continuously sounding its mournful warning whistle. Now a chorus of whistles from other craft indicated we were in the vicinity of New York harbor. But where?

The engines stopped, anchors went overboard, and for eighteen hours the big liner lay there, afraid to move.

"I don't know just where we are," the skipper explained. "But we've gone as far as I'm willing to go in this pea soup."

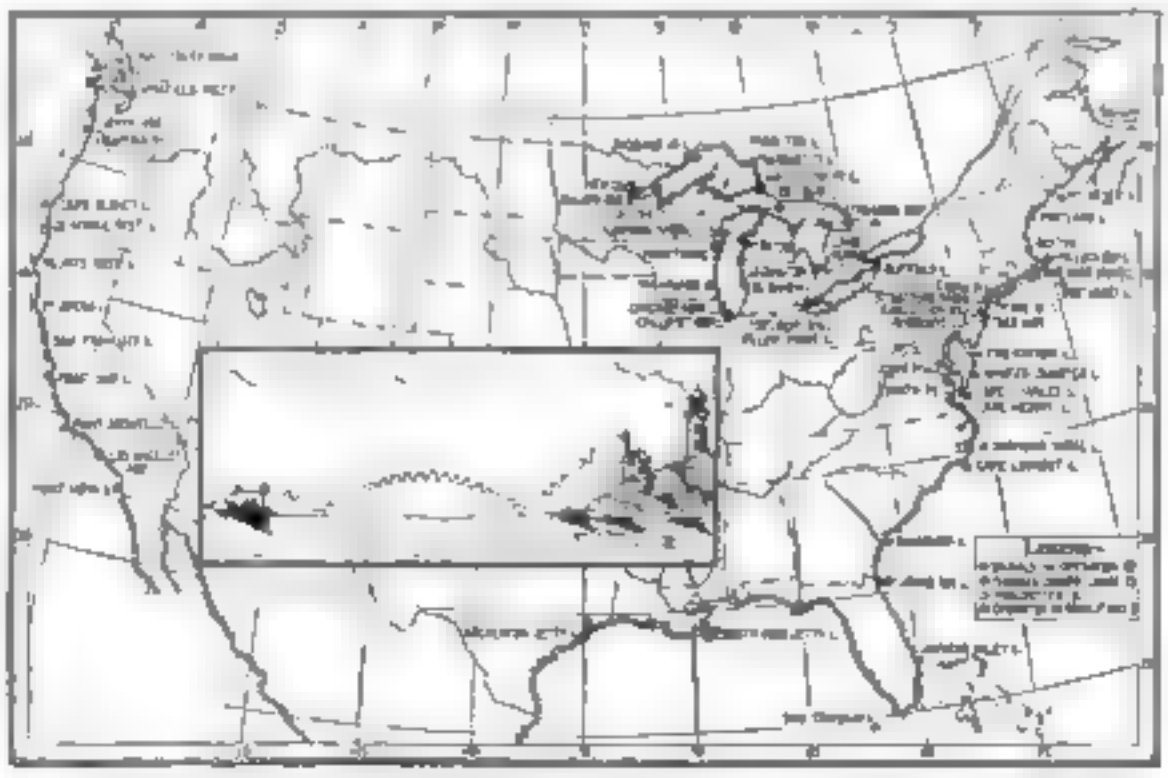
That was less than ten years ago.

Recently I was bound from Bordeaux to New York on another ship—and in a fog as thick. Yet as we approached Nantucket Shoals there was no lessening of speed. When I sought an explanation, the skipper, a seasoned Scot, invited me into the chart room. "That's the answer," he said, pointing to two colored pencil dots touching each other on the chart of our run. They indicated the ship's position.

"We had a glimpse of a few stars just before daylight," he explained. "That's where we got the blue dot. About the same time we picked up direction signals from a coast radio beacon. That's where the red one came from. You see, we can't go far wrong."

In those merging dots was written a remarkable story of the use of waves of radio, light, and sound to banish within the last decade much of the old terror of fog at sea, on land and in the air.

Newest of these triumphs are the radio beacon and radio compass. Radio beacons of the U. S. Lighthouse Service radiate wireless signals, and a single beacon enables the navigator to steer a safe course, even when fog completely shuts off visibility. Signals from two or more beacons in divergent directions enable him to chart his position accurately by triangulation of cross bearings. Moreover, the compass will tell him the



Dots show 99 radio beacons of U. S. Lighthouse Service, whose operation the sketch illustrates. Of these 43 are in operation, 3 operate on request only and 13 are under construction

location of another vessel hidden in fog, by determining the direction of her wireless signals.

Along the Atlantic and Pacific coasts, the Gulf of Mexico and the Great Lakes, Uncle Sam now maintains more than forty radio beacon stations. Coastwise steamers never are out of their range.

Recently, for example, a veteran shipmaster, Capt. Frederick W. Jones of the U. S. Shipping Board, guided entirely by radio compass, took his ship safely from Delaware Breakwater to Boston—all the way through heavy fog—though his route lay along Nantucket Shoals and around Cape Cod reefs where many a vessel has come to grief.

Fog over the mountain range no longer terrifies the aviator for signals from radio beacons tell him if he is on his course or if he is at the left or right of it

NAVIGATED once from New York to Boston through enveloping fog the great liner *Majestic* was directed almost entirely by radio bearings, so accurately that she passed between Nantucket Lightship and a nearly marking buoy!

Most large ships now are equipped with a radio compass, which is used constantly not only to take bearings but to avoid collisions. In heavy fog off the Pacific coast the steamship *Alexander* not long ago picked up the wireless signals of the steamer *Admiral* a shower vessel showing the [illegible] dimly ahead. Thus as a result [illegible] instances, a disastrous collision was averted.

The radio beacons, with equipment [illegible] the same as that for ordinary wireless transmission, send out signals automatically at regular intervals by a motor driven mechanism. Each beacon has its own identifying signal—a certain simple combination of dots and dashes of the Morse code.

The navigator notes the bearings of his radio compass until the signals are strong enough to establish the position of the sending station. He then turns the loop again to the point where the signals are weakest. At this point, which is more sharply defined than that of maximum intensity, the plane of the loop is exactly at right angles to the direction of the beacon. An indicator on the instrument shows at a glance the direction with relation to the magnetic compass.

RADIO dramatically proved its worth as a guide during the flight of Amundsen's dirigible *Norge* across the North Pole two summers ago. [illegible]

A fog bank rolling in on the sea to test the powers of modern science in guiding shipping. Above: Coast Guardsmen burning flares on the Massachusetts coast to aid in making rescues from a ship wrecked in a dense fog. In emergencies primitive methods still often serve. Seven men were saved

lost in a thick fog, the ship was in grave peril when its radio compass picked up signals from the wireless station at Nome, Alaska, turning possible disaster into an epoch-making achievement.

THE Government's present program calls for radio beacons at 200-mile intervals along the country's main routes. Unlike the marine beacons, however, these send out directed beams of radio signals, like the beam of a searchlight, along the course to be traversed. For an air pilot to follow the path of the beam is simply a matter of interpreting Morse code signals. If the plane is on its course, the signal is the single dash of the letter T. If the course is to the right, the signal becomes the dash dot representing the letter N. If to the left, it becomes the dot dash of A.

An elaboration of this system, recently introduced along the Government air mail route between New Brunswick, N. J., and Cleveland, O., combines the radio beacon with radio telephone facilities for the pilot. Not only is he guided, but he reports his position by telephone every five minutes. Another improvement, developed by the Radio Research Board of Great Britain, is a device which translates the radio waves from a beacon into light waves that are visible on the fluorescent screen of an oscillograph in the pilot's cabin.

FREDERICK A. Kolster, inventor of the radio compass, has gone his own device one better with a notable radio beacon." This actually is a "radio foghorn" for ships, in the form of a low power automatic radio transmitter which sends out a characteristic sign al audible for ten miles.

Of late, however, inventors have greatly increased the efficiency of audible fog warnings. One important advance is in the transmission of sound under water, where it travels with much less variation than in the air. Many submarine bells have been installed along our coasts. Ships pick up the submarine signals by means of microphones, placed below the water line.

Light signals, likewise, have been greatly improved. A powerful new ray which penetrates dense fog is supplied from vacuum tubes by neon gas.

To safeguard the passage of vessels through rock-ribbed channels, underwater beacons have been developed. These consist of submerged searchlights powerful enough to reveal hidden perils no matter how dense the fog.

A bituminous fuel briquette magnified 500 times, showing formation that proves that it originated as plant life

Dr. Reinhardt Thiessen, paleobotanist of the U. S. Bureau of Mines, whose research has aided invaluably in putting coal to new uses, examines a specimen of bituminous coal

Coal Too Useful *to* Burn

Chemists Already Make Bituminous into Medicines, Dyes and Fertilizers and May Make Tile and Rubber

By A. C. FIELDNER
Chief Chemist, U. S. Bureau of Mines

EVERYONE who has tried to keep clean in any neighborhood where soft coal was burned will be interested to know that research chemists in the Pittsburgh Experimental Station of the U. S. Bureau of Mines are busy at the present moment, making it smokeless. Literally, they are knocking the tar out of it!

More important, in so doing they are discovering new ways to change the smoke into valuable new products that everybody can use. Already—and their work has just begun—they have found how to extract from coal tars valuable material for preservation of wood and excellent antiknock fuel for automobiles.

The experiments are but an indication of how scientific research is swiftly revolutionizing the world's use of coal resources, and thus changing the whole face of industry.

At present, of the 578 million tons of bituminous mined annually in the United States, ninety percent is burned for heat, light and power, without recovering any of its precious by products. The other ten percent is converted into gas and coke. From two thirds of this other by products such as tar, ammonia, and light oils are recovered.

AT THE present rate of progress, however, we may expect to see the ratio reversed before many years. Comparatively little coal will be shoveled into the fire. It will be deemed too valuable as raw stuff for the manufacture of vital necessaries of life, as well as a source of more efficient fuels. Even now the list of everyday things derived from coal runs into the hundreds including dyes, fertilizers, explosives like TNT, medicines, drugs, solvents and preservatives.

It took about a lifetime to build up Germany a great coal tar dye industry, based on by-products of coke manufacture. But, thanks to modern research laboratories, it required only a few years for Germany to develop the commercial manufacture of wood alcohol from water-gas—a product of coal and water—to the point where it rang the death knell of the great wood-distillation industry.

AND American chemists, in another two years, developed a process of their own which is now operating at Belle, West Virginia, in the heart of the bituminous field. Plans are being made to enlarge this plant to supply the entire American yearly demand of ten million gallons!

(Continued on page 164)

Courtesy of Carnegie Institute of Technology

Making methanol from coal and gas by the Patart method. Under pressure and heat in cylinders zinc and chromium compounds change water-gas to wood alcohol

This is no nightmare, but a German health exhibit calculated to impress forever on people's minds the importance of maintaining correct posture. The skeletons are shown in the correct and incorrect attitudes for daily human activities at work as well as at play

Newest Harvest *of* Research

Skull of California "Ape Man" May Be Half Million Years Old—Heart's Electricity Photographed—"Death" of the Sun Predicted

Advances in many and widely diverse fields of scientific research, discoveries, inventions and theories, important because of their bearing on everyday life, are chronicled each month in these pages.

Sun's Collapse Predicted

A GREAT British astronomer Professor J H Jeans, says the sun is ready to collapse at any moment When it does, the earth will be frozen so cold nobody can live on it

A French astronomer M F Baldet, finds evidence that the planet Jupiter, largest in the sun s family, is shooting enormous volcanic bombs into space Some of the comets and fire balls that sometimes hit the earth may come from Jupiter

In our own universe of the Milky Way, and in countless others like it, such bombardments signalize momentous changes as time moves on

Of the many stars in our universe system possibly thirty billion modern reflecting telescopes are capable of photographing three billion Each is a sun. Most of them are larger and brighter than ours. Each sheds energy until it burns out. Stars at old age, called "white dwarfs," give little heat and light.

To determine the effect of wind on buildings, this and other models of skyscrapers are subjected to artificial hurricanes in a wind tunnel by the U S. Bureau of Standards, as described in the February POPULAR SCIENCE MONTHLY By varying the pressure on various parts of the structure it is possible to find where it is too weak and where unnecessarily strong. The tests are invaluable to builders

Professor Jeans calculates that our sun is perilously near the "white dwarf stage. Any day it may totter But, since a day in the universe may be millions of years, this is nothing to worry about

America Man's Birthplace?

WORKMEN, laying a sewer in Santa Barbara, Calif., found a skull buried eighteen feet a few weeks To them it was only a somewhat gruesome mass of bone, but to Dr A. H. Onsdal, an archeologist, it was a rare historic document. For his examination indicated, he said, that the skull was the nearest thing so far found to the "missing link" connecting man and the apes with common ancestry Undoubtedly he said, it is older than the skull of the famous Java ape man believed to have lived nearly half a million years ago The primitive ape man who possessed it could not have been able to speak except in grunts.

If Dr Onsdal is right and there seems excellent reason to believe that he is the find will add important weight to the theory recently advanced, that the birthplace of the human race was in the New World.

Oil Engine and Cheap Helium May Start New Flying Epoch

AVIATION engineers of England have perfected a new airplane engine of the Diesel type, which burns heavy oil in place of gasoline.

From the Fixed Nitrogen Laboratory at Washington, D. C., comes the statement of Dr. Frederick G. Cottrell, expert on the chemistry of the atmosphere, that helium gas may be obtainable from the air in unlimited quantities.

These two recent developments have an important bearing on the advance of aerial transportation.

A successful noninflammable oil engine will remove the fear of fire that now stands in the way of public confidence in flying. The new engine delivers less power than a gasoline motor, but also reduces fuel consumption.

An unlimited supply of nonflammable helium for the safe inflation of airships would remove the most serious handicap to development of lighter than-air craft. In ordinary atmosphere there is only one part of helium to 180,000 parts of air. But there is plenty of air.

Creeping Baby Is Trotter

A CAMERA, a cat, a bulldog and a nursery of babies were assembled recently in the psychological laboratories of Johns Hopkins University to determine what sort of stride babies use when they creep.

The answer was:

Babies are trotters.

Watched by the camera, the cat and the dog proved to be pacers, the weight of the body being alternately borne by the two legs on each side. The babies, however, in almost every instance kept their weight balanced diagonally between a leg on one side and an arm on the other, in the manner of true trotters.

Dr. Lenore H. Burnside found that usually the first attempts at locomotion consist of floundering and waving of arms or legs. Later the baby's arms begin to work alternately while the legs are still dragged. At last the infant raises his body and strikes out in a trot.

Light waves so that they may see what they say and improve their articulation. The sound waves, striking the receiver diaphragms, set up tiny currents in an electric circuit, which causes beams of light, reflected through mirrors, to represent the sounds exactly as they were uttered

Only by wearing open-weave fabrics can you get appreciable benefits from the sun's ultra-violet rays, according to tests made by this device recently in the U. S. Bureau of Standards. Only rays passing through the meshes have sufficient healthful action. The solid part lets through only five to ten percent. Dyed and aged thread let through the least, says R. Stair, who is pictured making tests on various samples in the Bureau's laboratories

Photos of Heart Electricity

PHOTOGRAPHY'S latest achievement, announced by Dr. C. E. Kenneth Mees, Director of Research in the Eastman Laboratories, is in recording faint electric currents of the human heart! The process, employing a string galvanometer, a delicate instrument for measuring electric currents, promises usefulness in diagnosing heart ailments.

Accidents Due to Blood

THE reason some auto drivers constantly have accidents while others have little trouble may be largely a matter of blood pressure.

Dr. Walter V. Bingham and C. S. Slocombe, psychologists of the Personnel Research Federation, New York City, have just completed experiments in which they find a definite relation between health and motor accidents. Among bus drivers and motormen more than fifty years old, men with high blood pressure were found to have more than twice as many accidents as those with normal pressure.

This excessive pressure, the psychologists say, apparently affects health and temperament to a point where it interferes with safe driving. Their investigations also showed that the longer a man drives the fewer accidents he has.

The towering new tobacco plant developed by Professors T. H. Goodspeed (left) and A. R. Olson of the University of California by the action of X-rays on sex cells of the parent plant from which the giant was produced. The common tobacco plant is shown between them. Their experiments confirm those of Prof. H. J. Muller, noted in this magazine last month

Mummies Sought in Arctic

MUMMIES of long-forgotten men of the Far North, older than those found in ancient Egyptian tombs, will be sought by an expedition of the American Museum of Natural History, this spring, exploring the Arctic Coast of Siberia.

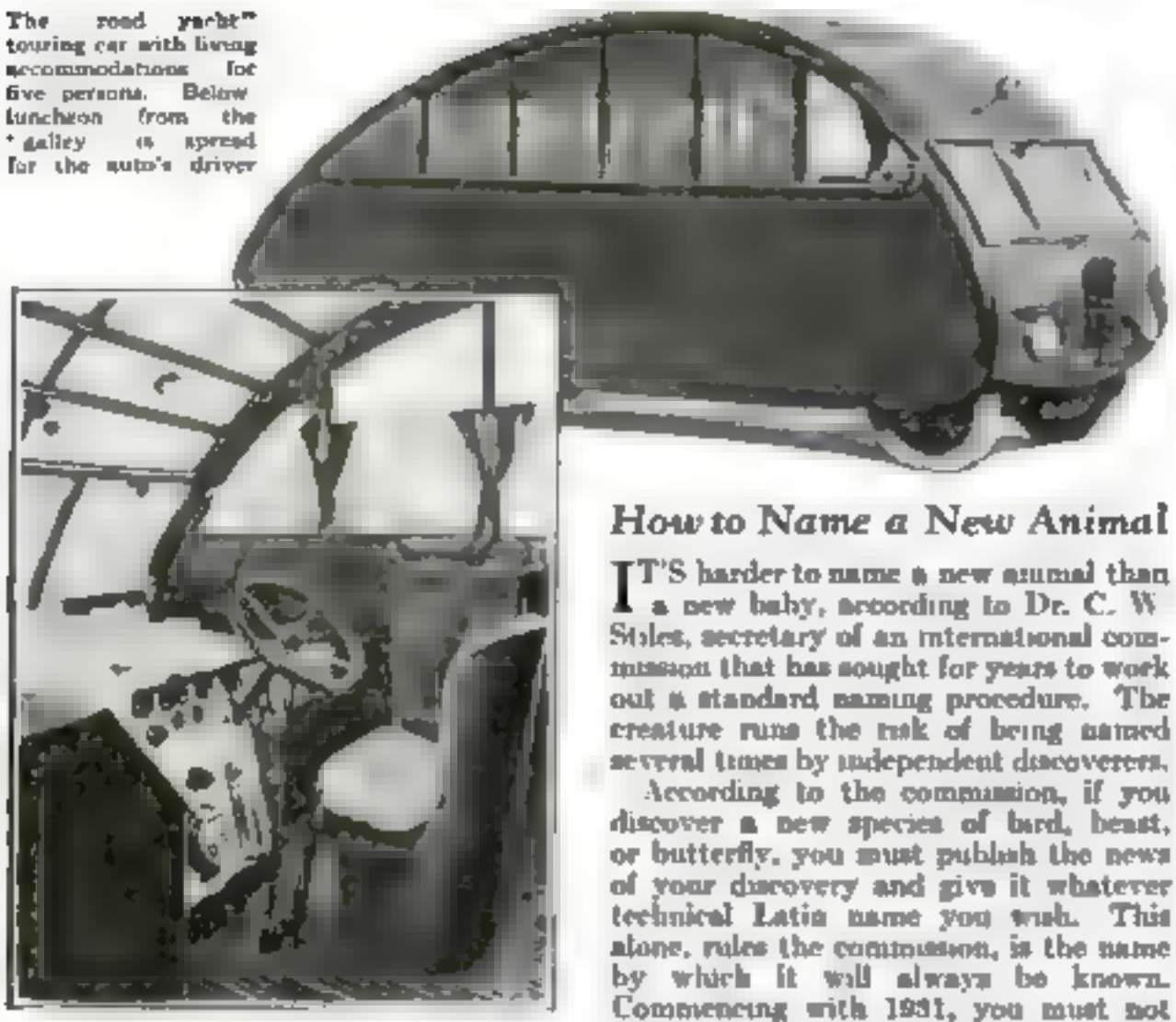
The remains are those of primitive Mongolians, believed to have been the first settlers of North America. Their existence was reported by the late Dr. William H. Dall of the Smithsonian Institution. For thousands of years they have been preserved by Nature in caves in the Aleutian Islands, where they were buried. They are believed to date to the postglacial period.

Natives of the Aleutian Islands believe the mummies hold a curse, and fear to go near them. It is related that a Swedish fisherman who attempted to remove a mummy to the United States in a boat was never heard of after he set sail.

This year's expedition is led by Harold McCracken, who has spent five years in the Arctic.

Insects Turned into Metal

SOME months ago a German chemist, Dr. N. D. Zelinsky, was making chemical analysis of certain insects. The process involved covering them with powdered copper oxide and heating them in small platinum crucibles in an atmosphere of carbon dioxide. He was astonished to discover that the insects turned to metal, with the delicate markings and structure preserved. As a result, museums may preserve rare specimens indefinitely.



The "road yacht" touring car with living accommodations for five persons. Below luncheon from the "galley" is spread for the auto's driver

"Road Yacht" Complete Home

THE man who drives with one hand will find that he may use the other to reach for a sandwich and a cup of coffee in a "road yacht" developed in London.

The vehicle, which looks like a large metal bug on wheels, is the latest in touring luxury. Speed of forty-five miles an hour may be easily attained. An electric "galley," completely fitted lavatory, two sleeping cabins, book shelves, writing tables, and a radio complete the equipment of this automotive innovation, which accommodates five persons

Big New Meteorite Studied

WHAT is thought to be the largest meteorite preserved intact for which the date of fall is definitely known is being studied by experts at the University of Iowa. It is a 110-pound chip from a celestial visitor that exploded about fifteen miles above Iowa City, Ia., according to Prof Charles C Wylie, one of the investigators. The chip buried itself in hard clay

Bottle Traces Ocean Current

A FLOATING bottle's journeys ended the other day when William Hannapus walking along the west coast of Ireland, picked it from the water and read the note it contained, "No. 1059. Please return to William Beebe, New York Zoological Park, or to the Hydrographic Bureau, Washington." Nearly a year ago the noted explorer Beebe had thrown the bottle into the Caribbean sea 2800 miles away the Gulf Stream had carried it to its journey's end.

More than a thousand such bottles were dropped by Beebe during this cruise. Thirty-one were recovered, mostly from Central American shores, but this one revealed caprices of ocean streams.

How to Name a New Animal

IT'S harder to name a new animal than a new baby, according to Dr. C. W Stiles, secretary of an international commission that has sought for years to work out a standard naming procedure. The creature runs the risk of being named several times by independent discoverers.

According to the commission, if you discover a new species of bird, beast, or butterfly, you must publish the news of your discovery and give it whatever technical Latin name you wish. This alone, rules the commission, is the name by which it will always be known. Commencing with 1931, you must not only name it, but also describe it so fully that no other species may be mistaken for it.

Nearly half a million species of animals have been named since the pioneer studies of the great naturalist Linnaeus, says Dr Stiles.

Saw Uses Sand to Cut Rock

A LONG steel cable, drawn at high speed and fed continually with wet sand, cuts through solid rock in a new type of quarry saw developed by Dr Oliver Bowles, of the U. S. Bureau of Mines. Tiny grains of sand, dragged across the rock face, serve as abrasives to groove it at a rate hitherto unknown. In Pennsylvania quarries the device, known as a wire saw cut quantities of rock without need of the costlier methods of drilling, blasting, and cutting.

Swastika May Trace Races To Lost Pacific Continent

MANY thousands of years ago there stood in the Pacific Ocean a continent where thrived a remarkable civilization. In a tremendous earth upheaval the continent vanished, swallowed by the waters. But before the catastrophe, adventurers from that lost land drifted to other continents and left their marks.

Such is the fascinating theory advanced by Col James Churchward, of India, to explain the origin of mysterious symbols found carved and painted on rocks.

Most famous of the symbols is the swastika cross found on rocks in America, Asia, Europe and Africa. In North America the rock writings, or petrographs, have been generally attributed to comparatively recent tribes of Indians. Colonel Churchward, however, contends that many of them are very ancient, and that their original source was the lost continent. With the aid of key symbols discovered in India, he claims ability to translate some of the mysterious writings.

Interest in tracing the family tree of modern man has been heightened by the recent statement of Dr. Ales Hrdlicka, noted anthropologist, that the low-browed grisly Neanderthal man, who lived some 40,000 years ago, may have been our direct ancestor, instead of a distant cousin of a different species. The belief has been that this prehistoric race was exterminated by the later Cro-Magnon men and left no descendants. In the remains of Neanderthal man, however, Doctor Hrdlicka finds new evidence that he formed a definite link in the long chain of human evolution.

Motorcycle Drives Sea Sled

HOW would you like to go for a motorcycle ride on the river? E. A. Cullum, pictured below, thinks river cycling a plausible idea even though his first attempt to cross the Thames resulted in the sinking of his queer machine and the second fared little better. His vehicle consists of a motorcycle built into a float of the sea sled type.

With a motorcycle built into a sea sled, E. A. Cullum has a remarkable water craft, which runs on tranquil surfaces, but the Englishman's efforts to cross the Thames River have so far been unsuccessful

Gear-Wheeled Roller Skates

SKATES like those seen below would allow you to drink that extra cup of coffee and still get to work with time to spare, for the remarkable speed of thirty miles an hour is claimed for them. The effective motive power for these up-to-date "seven-league boots" is furnished by the downward step of the skater through a ratchet gear wheel. Springs that operate automatically return the carriage to the original position ready for the skater's next stride.

The name of "walking machinery" was given to the skates when they were shown at the International Inventions Exhibition at London. The novel skates proved to be one of the most popular of the many interesting exhibits.

Thirty miles an hour is claimed for roller skates, called walking machines, which are driven by ratchet gear wheels that act wherever you take a step

Self-Sprinkling Roads

CLAY roads are kept moist, firmly elastic, and free from sun-dried cracks in Michigan by the addition to the clay used in building them of an odd chemical that absorbs water from the air. The resulting compact mass stands up well under ordinary traffic, according to A. L. Hurridge, of the State Highway Department, who developed the novel idea.

Calcium chloride, the chemical used, has already proved its usefulness for gravel roads as well. Used in the top dressing of gravel, it renders the road dustproof. No water wagons need sprinkle the highway, for the grains of the chemical seize droplets from the air itself. Six tons of the chemical are used on each mile of road.

Sea Lions Caught with Nets

THESE seals and sea lions are said to be experiencing a new sensation, for heretofore, it is declared, this type of animal has never been caught and brought in with nets. The picture below shows a small schooner off the west coast of Mexico with what is reputed to be the first haul of this kind, made with netting of tremendous strength.

Five-Mile Road of Gold Ore

WITHIN the concrete paving of a five-mile stretch of Colorado road, just laid, lies $20,000 worth of gold. Highway engineers found that rock from mine ore dumps was the nearest at hand and most plentiful for mixing the concrete. Despite the quantity of gold it contained, there was not enough to pay for the expensive process for its extraction.

How Colors Aid Eyesight

ARTIFICIAL blue light is best for close work, an investigation reveals. Red is preferred for seeing distant objects, ordinary white for all-around work.

Junk Makes Queer Golf Links

HAVE you a dump heap near your home? If so you might lay out a golf course for there are the makings. Pipe fittings, a number of loose bricks, and a variety of crockery went to form hazards for this sporty nine-hole course that a large gas company at Hell Gate, N. Y., laid out in its front yard. Upon these links the player must be careful not to send his ball out of the yard with an unexpected bounce off a piece of steel tubing.

Dam Holds Water with Water

WATER holds back water in an amazing new type of dam, said to be extremely economical to construct, proposed by French engineers. If successful tests of a plaster model are confirmed, a 250-foot dam will be erected near Marege, France.

Instead of one solid masonry wall, the dam will consist of five thin concrete ones across the Haute-Dordogne Valley. Each, looking down the valley, is lower than the last, the farthest downstream being only forty-six feet high. When water is running over their tops they will appear like cascades.

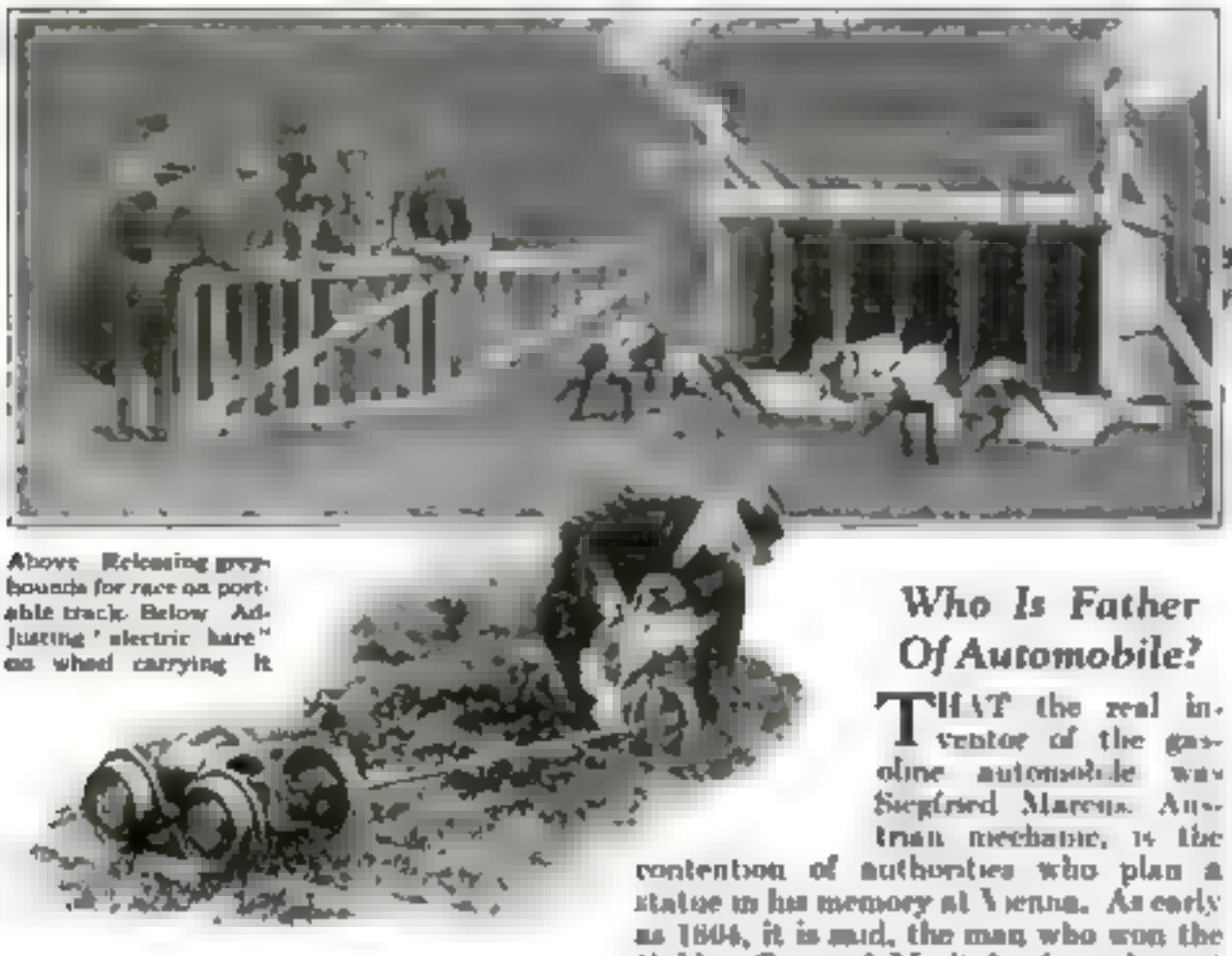
Water fills the space between them, to make up the bulk of the dam. Its weight partly equalizes the pressure on opposite sides of each partition, unlike an ordinary dam that has nothing but its own strength to oppose the water's downstream push. Hence, the partitions can be made exceedingly thin with safety, and the total cost of the whole five is said to be far less than that of one massive wall.

Plan to Utilize Moon Power

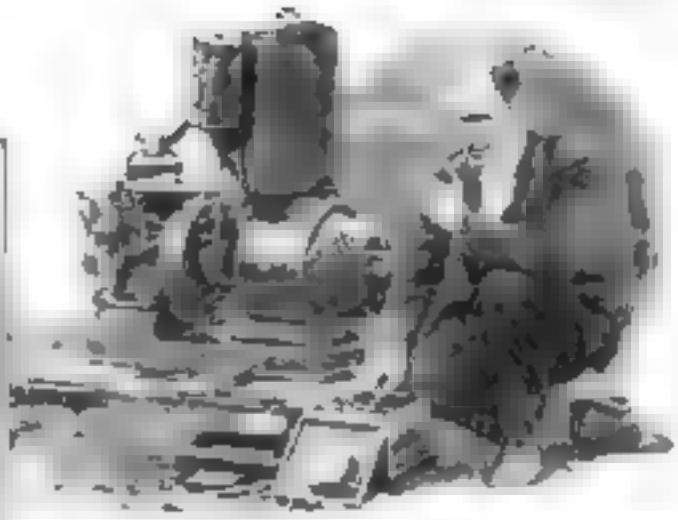
PUTTING the moon to work for us is the not far distant prospect held out by the National Geographic Society, by the use of the same force that creates the tides and that makes the great liner *Leviathan* weigh ten or twelve pounds less when the moon is directly over it. "In years to come," the society announces, "this moon-force may be harnessed to create power; already plans are under way for the construction of tidal power stations."

The first seals and sea lions ever caught, so far as known, in nets, landed in by a schooner off the coast of Mexico. Special netting of tremendous strength is said to have made the feat possible

Portable Track for Racing Greyhounds



Above Releasing greyhounds for race on portable track. Below Adjusting "electric hare" on wheel carrying it



Operator at the motor watches the race and, by regulating power, controls the speed of "electric hare," keeping it beyond reach of pursuing dogs

FLEET greyhounds vie for speed records as they pursue the "electric hare" of a new racing outfit, designed by an English inventor and recently successful in tests at Beddington. Though in design it resembles the standard race tracks that have popularized greyhound racing in Britain, the latest apparatus is portable and can be set up at any sports meet or fair.

At the starting signal the hare is set in motion; a second later the hounds are in full pursuit. Though the operator sees that they never catch the hare (for one was torn to pieces when this happened at Southend) they are spurred to great bursts of speed. Their quarry darts along in a lifelike manner at the rate of its motive power—a car that is an electric motor on wheels, running along a miniature railway of narrow gage.

Electricity to run the outfit is generated by a gas motor and a dynamo.

Twin Panama Canal Foreseen

DO WE need another Panama Canal? Although the great waterway is now operating on a sixteen-hour schedule, it may eventually require constant use, indicates a report of the governor, M. L. Walker, to the Secretary of War.

During the last fiscal year shipping passing through the canal set a new high record of 5475 commercial vessels alone, not to mention other craft that brought up the average to nearly seventeen a day. Total cargo carried through the canal was nearly 28,000,000 long tons. Tolls exceeded $34,000,000. This is five times the traffic of twelve years ago; and if it continues to increase, enlarging of the canal or the digging of a supplemental waterway across Nicaragua may be necessary. Additional locks in the present canal, a suggested remedy, could increase its capacity only about fifty percent, it has been estimated.

Who Is Father Of Automobile?

THAT the real inventor of the gasoline automobile was Siegfried Marcus, Austrian mechanic, is the contention of authorities who plan a statue to his memory at Vienna. As early as 1864, it is said, the man who won the Golden Cross of Merit for incandescent lamps and rotary pumps he invented made the world's first motor car. Eleven years later he perfected a model and carried passengers. Not until 1883 did Gottlieb Daimler, the German, invent the gasoline engine that assured its success.

In the first engines the gasoline was exploded by heating the outside of a closed tube connected with the cylinder. It was impossible to time the explosions properly, since they lagged behind the piston's motion. Later the electrically ignited motor became forerunner of today's efficient power plants.

Paving Put to Test

HARD surfaced highways are the most economical to motorist and town or state alike, according to W. H. Rhodes, New Orleans engineer. "The efficiency expert of a tri-state bus company," he recently told the American Society of Municipal Improvements, "found that four heavy buses running over gravel cost two cents a mile more in tires than those running over asphalt. A conservative estimate of the saving in wear to the tires of an average car is at least six tenths of a cent a mile."

On all roads carrying more than 1000 cars a day he declared, the providing of a hard surface would be a real economy, less costly than repairing the worn-down highway.

Wheels Made of Cotton

WHEN cotton manufacturers sought to find new uses for their fabric, they decided to make wheels of it! Now these odd wheels, used on hand trucks to enable them to roll quietly through factories and offices, have proved successful in recent tests conducted at the War Department. One of them, revolved against a grinding surface, showed no appreciable wear after running an equivalent of more than 350 miles. Experiments are being made to see if they can be adapted to automobile trucks.

Average Auto Lasts 7 Years

WITH average luck, you might expect your car to last seven years, concludes Prof. C. E. Griffin, of the University of Michigan, who investigated the history of 100,000 cars. Half of them were out of commission at the end of seven years, but, after twelve years, more than 3000 were going strong.

Dam Is Engineering Feat

THE great Pacoima Canyon Dam, three hundred and eighty-five feet high, six hundred feet long and a hundred feet thick at the base, considered one of the outstanding engineering feats of our time, will protect California's fertile San Fernando Valley.

A remarkable view looking down on the $1,500,000 Pacoima Dam, 385 feet high, which presented tremendous engineering problems and is two years in building

Mail Trapped by the Desert

TREACHEROUS at all times, the legend-famed Irak Desert of Mesopotamia becomes a sea of mud in rainy seasons, and motor cars attempting to cross it are trapped times without number like flies on flypaper. But mail must in spite of all circumstances traverse the forbidding wastes between Bagdad, in Mesopotamia, and Beirut, Mediterranean port of Syria. In the illustration the official mail is being "rescued" and sped on its way by sturdy natives, who are digging out a marooned transport car

Navy Issues Ocean Air Maps

FOR the aid of trans-Atlantic flyers, the Navy Department's hydrographic office has commenced the publication of "pilot charts of the upper air," showing the most feasible aviation route for each month. They will be issued throughout the year.

Oil Ditch a Fabric Pattern

FASHION designers seeking new patterns may well turn to Nature, as the unusual photograph below shows. It is the chance shot of a photographer who saw in the curious mosaic of circles and ovals of an oil ditch an out-of-the-ordinary camera subject well worth recording. The striking record he obtained was one of the best exhibits at the London Salon of Photography.

Formation of ovals and circles in many iridescent colors on the surface of an oil ditch—one of the loveliest pictures in an English exhibition

Building Wreckers Imitate Explosion

The collapse of buildings almost 100 years old looked like an explosion and sounded like one, being heard for blocks, when the ancient structures yielded to wreckers' sledges

NO, YOU'RE wrong, this is not a picture of an explosion, although it may look like one. In reality the photograph was made when wreckers demolished several ancient buildings in Jersey City, New Jersey.

The old structures were almost 100 years old and very solidly built. The crash when they finally surrendered to the razers' sledge hammers was heard several blocks away. The buildings had been condemned, and were destroyed to make way for new construction.

Smaller Dollars Save Millions

TWO thirds the size of the old currency, the small new dollar bill just designed by the U. S. Treasury is expected to save the Government four million dollars a year. You will soon be carrying the new-size notes, which were scheduled to be ready by the time this magazine is printed—although it is said that half a billion will be printed before the first is issued.

Since twelve of these can be printed at once on a single sheet, as compared with eight of the old kind, the cost of printing is reduced. Another important feature, studies have shown, is that the smaller bills last much longer. They can be put in the ordinary wallet without folding. Ordinary dollar bills have an estimated life of eight months, before, limp and soiled, they return to Washington to be destroyed and made into souvenirs.

Making All Russia Gas-Proof

CIVILIAN inhabitants of Moscow, Leningrad, and other Russian cities—men, women and children—are now being provided by the government with "personal gas masks" and instructed in their use, according to reports. "It is our duty to supply them not only to every soldier but also to every working man and inhabitant of the districts behind the war front," Commissar of War Voroshilov told the Fourth Soviet Congress, urging that in the unlikely event of war Russia should not be unprepared.

Other suggested plans for protection against possible future air attack by gas include dwellings with gas-tight rooms, supplied by pipe with fresh air from plants with stacks reaching into the air.

Heating Plants on Roofs Next?

HEATING plants on the roofs of buildings may come within a few years, H. Leigh Whitelaw, of New York City, recently told the Pennsylvania Gas Association. Skyscraper owners, he said, would increase their profits by leasing the basements that now hold the heaters. The technical difficulties of adapting heating systems to the topsy-turvy plan could be overcome, he says.

Hens Smash Laying Records

FIRST place in the international egg-laying contest just conducted by the Washington State Agricultural College has been won by ten Barred Plymouth Rock hens owned by Prof H B Bensmore, of the University of Washington. In one year his pen of hens laid 2807 eggs. This is said to be the first time in poultry history that Plymouth Rocks have beaten all other hens, including Leghorns, which took second place.

Hotel Radio in Each Room

NOW the guests of a New York City hotel have radio programs on tap through the touch of an electric switch. The entire hotel has just been wired for radio, and two central receiving sets are on the thirty-first floor. Nearly all the 1600 rooms have loudspeakers.

Plants Made by Chemistry

"Seeds" of Metal Salts, Put in Strange, Poisonous Solutions, Sprout Like Sea Vegetation

Fresh-Water Algae

Red Seaweed

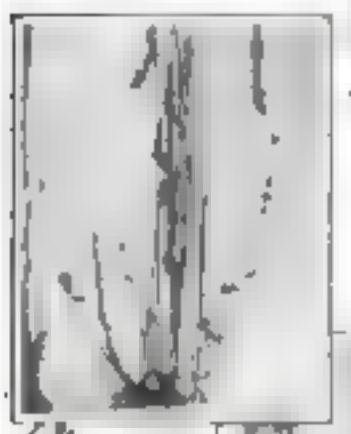
NOW artificial plants are grown in test tubes through the chemist's magic. The photographs on this page made by Dr. L. Rade show how easily these chemical plants reproduce nature's own products. Like magic, salts of metals are the seeds which are dropped into solutions of sugar or such other nutritive substances as salt water and sodium silicate or potassium ferrocyanide, and they sprout to form mass of tall stalks.

When lecithin, a waxy substance from the yolks of eggs is placed in water bursting threads sprout from it and appear under a microscope as grass or flowers.

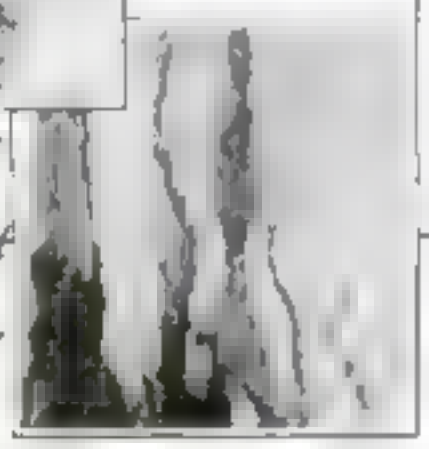
All of the chemical plants are easily created for low power by heat and [illegible] there is about [illegible] to give back the spark of life.

Green Sea Algae

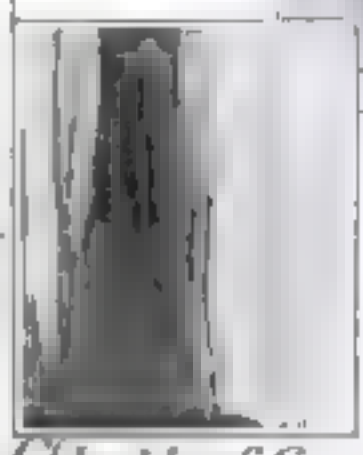
Branching Marine Form



Chloride of Iron Plant in Tumbler



Chloride of Copper Plant in Potassium Ferrocyanide



Chloride of Copper Plant in Salt Water

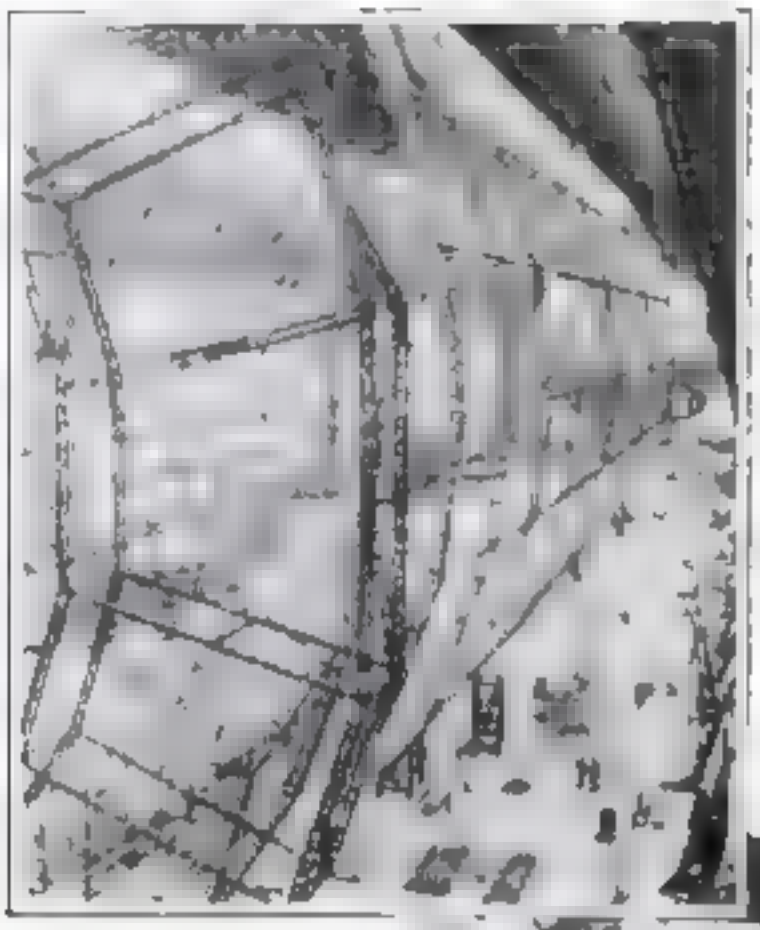
Plant Scum

Some Typical Sea Plant Growths

Sulphate of Copper Plant

These remarkable photographs show the similarity of the chemically produced artificial plants to the natural ones. The four at the top of the page show lecithin, from egg yolks, growing. The first three are magnified 50 times and the fourth, 150 times

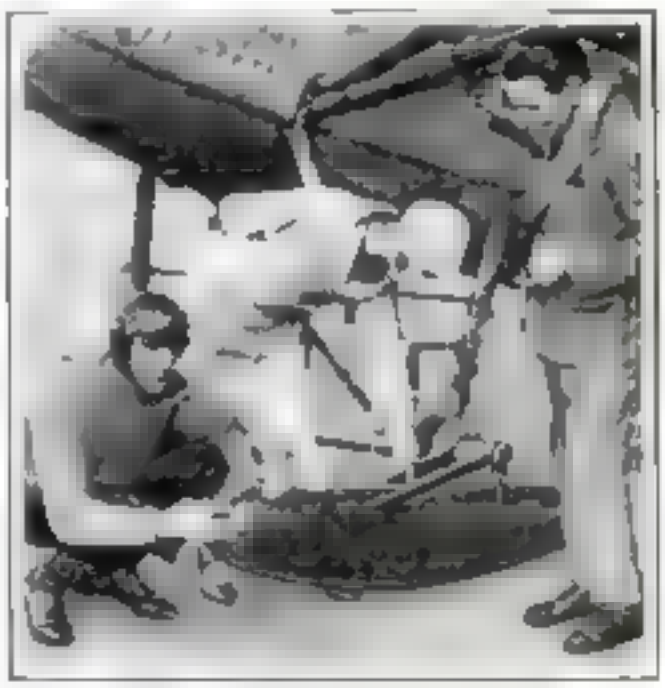
Flyers Turn to New Ideas



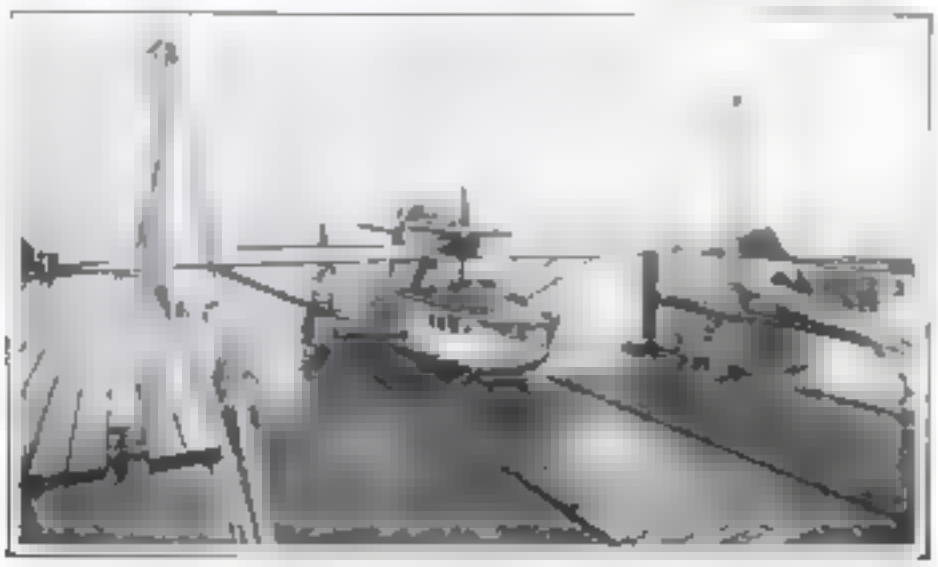
Gigantic duralumin frame of the new Zeppelin LZ 127, being completed in Germany by Hugo Eckener, builder of the American dirigible *Los Angeles*

The first hydro glider equipped with air-filled pontoons as well as in a recent test in Berlin, is drawn by a motor boat, as shown in the photograph, but it is said to be equally successful in flight. The inventor, Hans Hirth, who first tested the craft, declared it more than met expectations

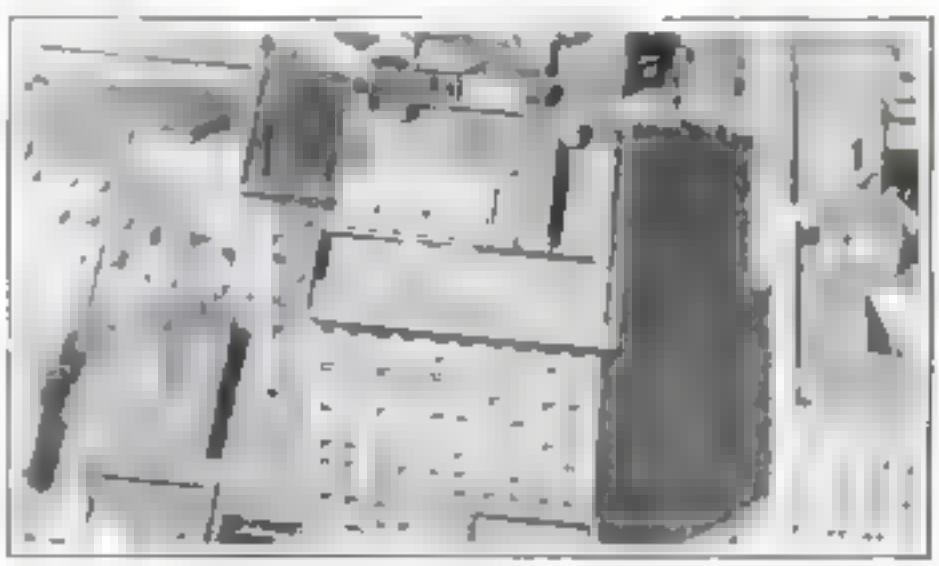
Small dirigible now being built anywhere at [illegible] is [illegible] by George H. Kenworthy. Dirigible is only few [illegible] long and rests on the dirt until the flyers pull down the ship



Taking-off in ten seconds is easy with this strange craft, which landing gear, according to reports of recent tests in France. Danger of flooding the wings when motor stops is said to be eliminated. Two floats are built on to the landing wheels at the sides, one of which is shown at the extreme right



The first floating dock for giant flying boats is shown here receiving the Dornier Superwal superwhale in Germany. With a supporting capacity of 100 tons, it can also receive airplanes and launch them by catapult



The largest "aerial signpost" in a city atop a Denver building, is a 110-foot arrow, directing flyers to Lowry Field. It is visible from a height of 5000 feet. The plan is recommended to all owners of large buildings

Toy Car Claims Speed Mark

FASTEST of toy automobiles, says the maker, is a new lightweight car for the children. Among its novel features are a safety system of double brakes and a patented bicyclelike sprocket that enables the youthful driver to go forward, reverse, brake and coast at will. Steered by the conventional wheel, it is propelled by a chain drive similar to that of a standard racing automobile. The car is of all-steel construction, hence durability is claimed as one of its virtues.

Baboons as Servants Advised

IF YOU need a faithful, efficient house servant, not subject to human failings, try a baboon. That is the startling advice of Prof F. A. Lindemann, of Oxford University, England. In twenty years, he declares, there need be no servant problem This is the time it would take, he says, to breed apes intelligent enough for simple household duties—dusting and sweeping, for instance.

Steam Well Power Unlimited

GREAT, undeveloped power resources —the smoldering fires within the earth—have just come in for attention with a recent survey of the California natural steam wells. Two experts of the Carnegie Institution, Dr. E. T. Allen and Dr. Arthur L. Day, have reported the results of the first thorough investigation of its kind in America. Despite eight borings in the local area where natural steam is abundant, a little valley near San Francisco, the tapping has caused no apparent reduction, they find, in the available pressure of from sixty to 275 pounds. There seems no reason why further enterprises should not be conducted on a larger scale, as has been done at Larderello, Italy, to furnish commercial power

The Italian natural steam, they point out, contains corrosive substances and must undergo a costly purification before it can be used in machines, but the California steam is pure enough to use directly as it comes from the ground.

Seaplane Can Go 4000 Miles

EVERYTHING new in aeronautical science is said to be incorporated in the Navy's latest seaplane—a giant with a cruising radius of 3000 to 4000 miles that could conquer the Pacific! The first of these "PN-11" planes, secretly built at Philadelphia, has just been completed, and twenty-five more are to follow

Secretary of the Navy Wilbur, denying reports that the plane will be used in a Pacific or globe-girdling flight, states that it will be placed in regular service. It is designed to carry about 1500 gallons of gasoline, more than Commander Byrd's huge plane bore on its flight across the Atlantic to France.

New Way to Tell Time in Bed

TO TELL the time, without turning in bed, an English inventor had devised an apparatus that projects to the ceiling a magnified, illuminated image of his watch-face! He slips his watch into the device before retiring, a touch of an electric switch conveniently located on his bed at any time during the night and the hour is indicated above him.

Within the box-shaped apparatus are an electric bulb, a mirror, and a lens to accomplish his end. It is the reflected, magnified image of the watch or clock face that the sleeper sees. The annoyance of a noisy timepiece is obviated, as it can be placed far enough from the bed to make its ticking inaudible.

A $275,000 Floating Road

ENGINEERS recently laid a unique floating roadway when they constructed a $275,000 underpass to avoid a grade crossing at South San Francisco. To pass beneath twelve main-line railroad tracks, the road dips three feet below sea level. It rests upon a mud and water foundation alone; six hundred steel anchors hold it in place.

New Chemical "Ice" for Rink

NO MATTER how hot it is, you can skate and coast as in midwinter on a new kind of "ice" devised by German chemists, now installed in a Breslau exhibition hall and skating rink. Although, it is said, you can slip and fall on it as effectively as on the natural substance, the new compound does not melt even at a heat of 98 degrees!

Resembling the frost that collects on ammonia refrigeration pipes, the artificial product is poured on wood and hardens quickly. Its manufacture is by a secret process, although it is known to be purely chemical: no machinery whatever is needed in order to make it.

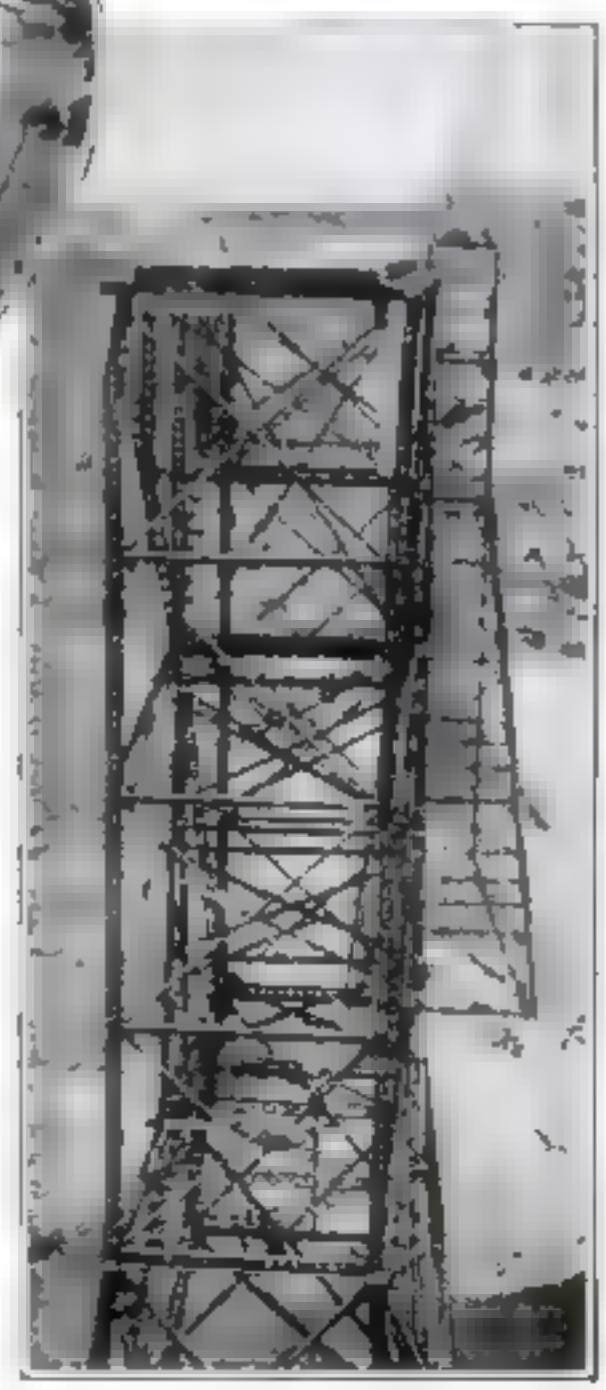
Planes Use Costliest Wood At $600 for Thousand Feet

PROBABLY the highest-priced lumber that comes from a log, lumbermen say, is the hand-picked Sitka spruce used in the building of airplanes. Not every log will supply the quality demanded a clear straight-grained spruce of the highest standard. Only a half dozen mills in the Pacific Northwest can supply the rare wood, and it takes from three to six weeks to assemble a carload. The average airplane requires for its manufacture nearly a thousand feet of the spruce, at $600 a thousand, for its wing beams, struts and other parts.

Bridge Nearly 500 Feet High

IN A short time, what is said to be the highest bridge in America—if not in the world—will be completed. It spans an Idaho river north of Twin Falls, at the tremendous height of 490 feet. This unusual photograph below shows the structure being thrown up across the ravine. When it is finished, it will have cost $800,000.

The Washington Monument, if set alongside the bridge, would rise only sixty feet above it—the mere height of a tree. A twenty-seven foot wide platform, more than a quarter of a mile long, tops the girders.



An unusual close-up photograph of what is called America's highest bridge, in Idaho The 550-foot Washington Monument would top it by only 60 feet

Steel House Erected in Little Over Three Hours

WHAT is said to be a speed record in home construction was achieved recently at Forest Hills, N. Y., where architects and engineers saw workmen erect the steel framework of a two-story dwelling in three hours and twenty minutes. It was a demonstration of a new system of house building by the use of standardized steel members similar to those used in constructing skyscrapers.

When Robert Tappan, architect and engineer who designed the steel house, mounted its skeletonlike beginnings and gave the starting signal, the fabricated frame began rising.

By going a step farther and turning out factory-made porches, vestibules, chimneys and bay windows, it is possible to construct seventy percent of a house's parts in an industrial plant, Tappan says. He plans to erect houses of this type throughout the country. Through the economy of standardization, he declares, they will cost less than wooden houses do today.

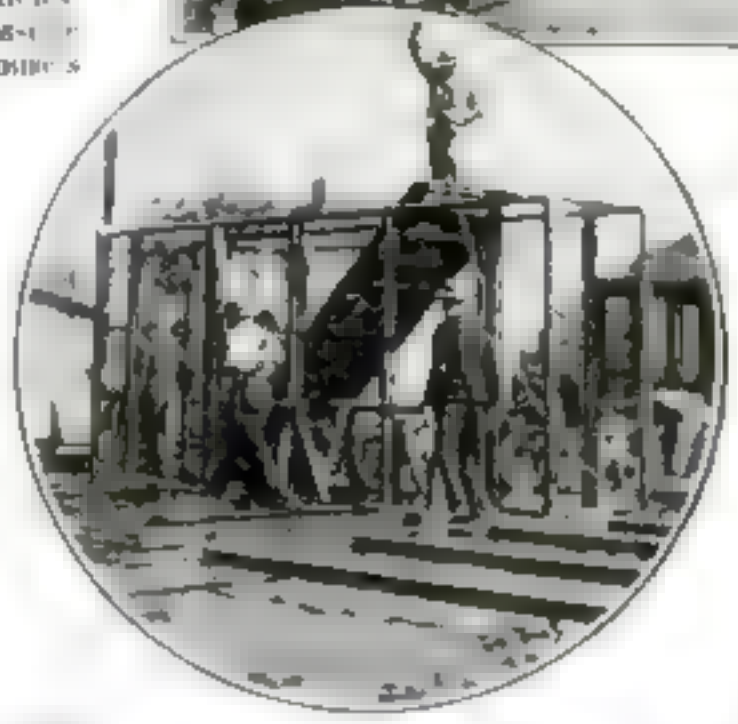
Steel framework makes the house practically indestructible, it is said, and the dwelling cannot warp or shrink.

A workman waves a flag to signify completion of the assembling of the factory-made steel frame of a dwelling at Forest Hills, N. Y., in three hours and twenty minutes. At the left, Robert Tappan, architect and engineer who originated the idea and plans to build such houses throughout the country, gives signal to start the main construction

Foolproof Elevator

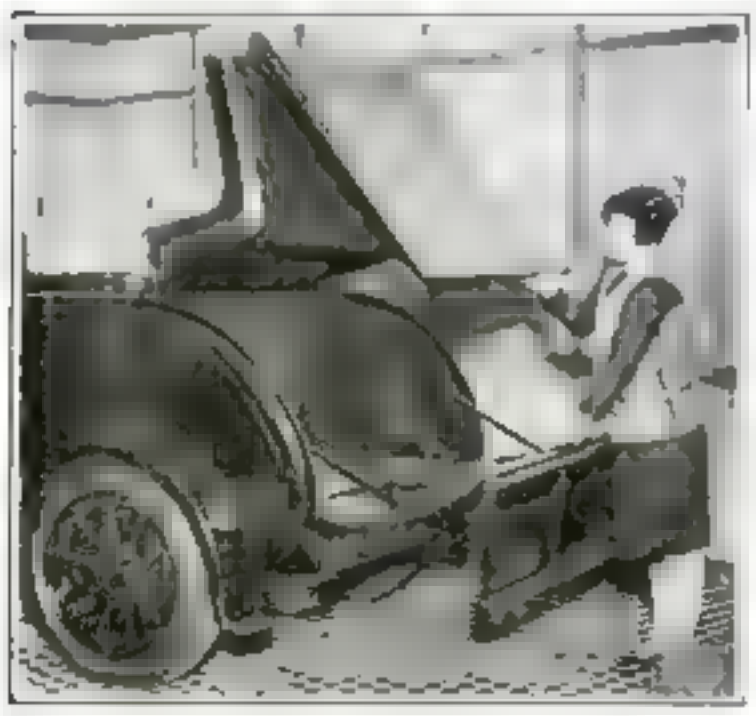
YOU can't be carried past your floor in the latest type of automatic elevator, recently introduced in New York and other American cities. On the ground floor the operator presses a numbered button for every stop desired. Then he starts the elevator; without further control, it shoots upward and stops at the first floor called for. The doors fly open automatically; a touch of a lever closes them and the elevator continues until it stops at the next level desired.

So perfect is the mechanical control that the elevator always stops with its bottom edge flush with the floor. On its down trip, the elevator again stops automatically at every floor where a waiting passenger has pressed the "down" button on the wall of the corridor.



Open Car and Sedan in One

WHEN the weather is on its bad behavior, the open car loses much of its attractiveness. It is a quick change to a closed one with a remarkable new convertible type of automobile recently exhibited at Westminster, England. From the rear compartment, as seen below, unfolds a substantial top that is quickly set in place and made weather-tight. In fair weather the covering is completely hidden and the car's lines are unmarred by the presence of a folded top. Even with the cover folded away, there is said to be ample space in the rear compartment for luggage, tools and spare automobile parts.



The new English folding top that collapses into the rear of the motor car when not in use and in bad weather converts the machine into a sedan. When out of service it cannot be seen

Any Questions?

THIS magazine is always glad to answer inquiries of readers concerning all subjects within its scope and to furnish names and addresses, whenever possible, of the makers of articles described in its pages. Replies are made as promptly as possible in view of the time required for research, and every effort is made for absolute accuracy. Inquiries should be accompanied by stamped self-addressed envelopes and directed to Information Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Star a Pulsating Gas Bubble

"A GLOWING gaseous bubble of gas that shrinks and swells" is the astronomer's latest description of Mira, a remarkable star that graces the celestial equator. Recent observations with the aid of a light-recording instrument devised by Prof. W. S. Adams, attached to the great 100-inch telescope of Mount Wilson Observatory, prove that as the star becomes periodically bright and dim, a phenomenon of which astronomers have been aware for centuries, it actually waxes and wanes in size. Astronomers believe the amazing power that blows the gases composing the star outward and sucks them in at intervals of eleven months comes by extraction of energy from the atoms of matter.

Betelgeuse dims and brightens for a different reason, says Dr. Joel Stebbins, University of Wisconsin astronomer. A red star, such as this one, he proposes, probably has "star spots" that, rotating, periodically obscure part of its face.

Magnifying Your Strength

BY THE lightest touch of your hands, through a marvelous new mechanical device, you have power enough to steer a ship or aim a huge gun. These are the latest uses seen for the "torque amplifier," developed under direction of H. W. Nieman at the Bethlehem Steel Works and described in the January POPULAR SCIENCE MONTHLY.

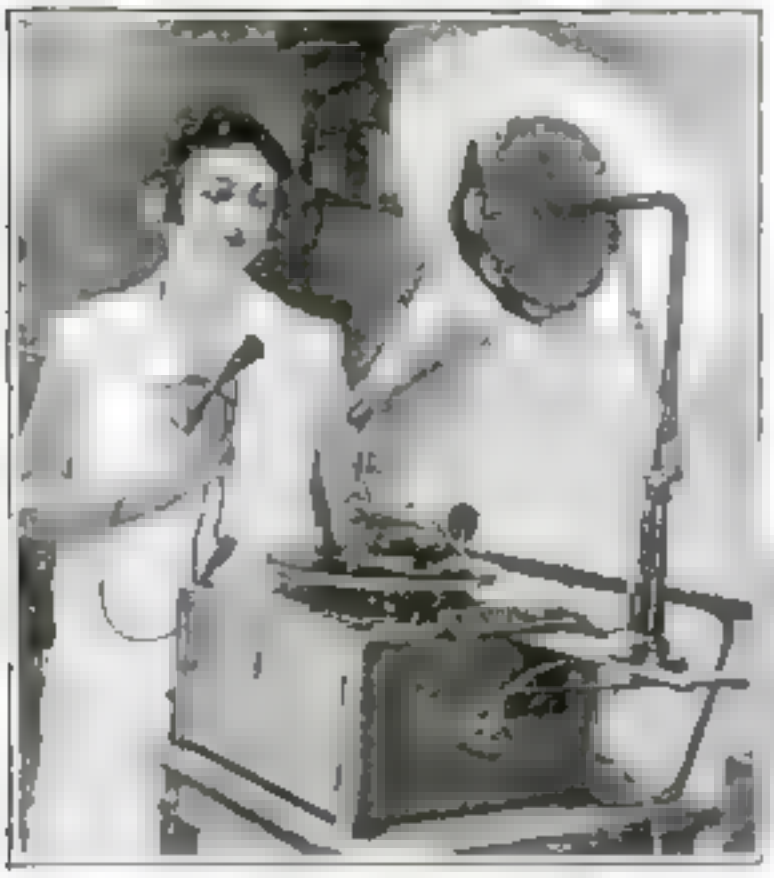
When you turn the "control shaft," the "work shaft" turns in the same direction and its power is ten to fifty thousand times greater than yours!

Bright Children Not "Queer"

UNUSUALLY bright children are neither queer nor likely to become so later. That is the opinion of a number of authorities. Clever children, they agree, generally come of distinguished parents, have unusually good health, are fond of play, are popular with other children and show no peculiarities.

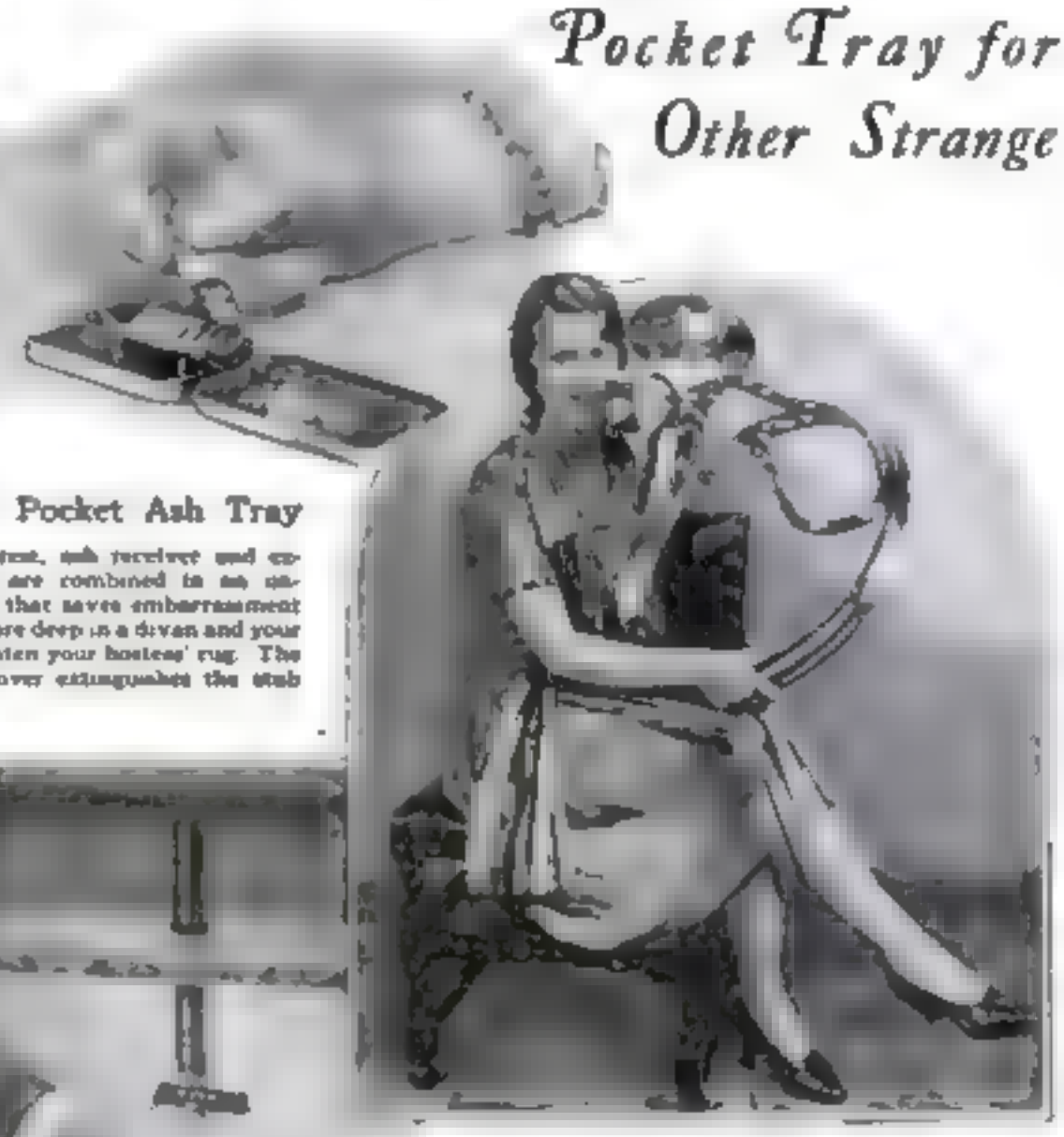
Odd Utilities *and*

Ferris Wheel Preserves Phone Girls Bundles Pocket Tray for Other Strange



Phonograph Relieves Phone Girls

"The number is changed; please consult new directory," a mechanical voice now tells phone users in Paris. When a changed number is called the operators save labor and avoid delaying other calls by plugging in on the ever-running device



A Vest Pocket Ash Tray

Cigarette rest, ash receiver and extinguisher are combined in an unusual case that saves embarrassment when you are deep in a divan and your ashes threaten your hostess' rug. The air tight cover extinguishes the stub

What a Harmonica Grows Up to Be

A tuba, one would call this instrument at first glance, but, believe it or not it is a harmonica. Risen from the lowly level of the mouth organ, this carries the game of symphonic rhythmatic bass harmonica horn. Soloists in orchestras play on it

Eggs Kept Fresh by Daily Ride on Tiny Ferris Wheel

Altering of their position retards the natural ageing of eggs, according to Australian Government food experts, who entered this device in a recent food and cookery show in London. The apparatus can carry a total of 480 eggs

Ending Nuisance of Wet Umbrella

Damage to floors and to clothing is avoided by the umbrella holder illustrated above for churches and halls, invented by Ambrose O'Rourke, of New York City. The holder is attached to the end of a pew or row of seats, as shown at the extreme left; a tube fitted into the bottom drains the water through a hole in the floor into a pail or other receptacle that is conveniently hung. Losing umbrellas in coat rooms is also ended by the novel device

Novel Golf Scorer in Watch Case

Disputes are avoided by this device whose stem you press at every golf stroke. It totals each hole around the dial, adding them all up in the center

Useful Oddities

Eggs—Phonograph Assists Wrapped by Machine—Cigarette Ashes—New Inventions

A Slot Machine Soda Fountain

A nickel in the slot gets you your favorite soda in an establishment recently opened in New York's Great White Way district. The coin makes the machine set an individual cup under the spigot and start the flow. Open the door, there's your drink all mixed

Garage Door Dogs

An ingeniously simple but positive device to hold garage doors open is a pointed spike fastened on a tiny metal rack. When dropped it sticks into the ground, when not in use it rests on a holder. A touch of the foot operates it

Odd Envelope Licker

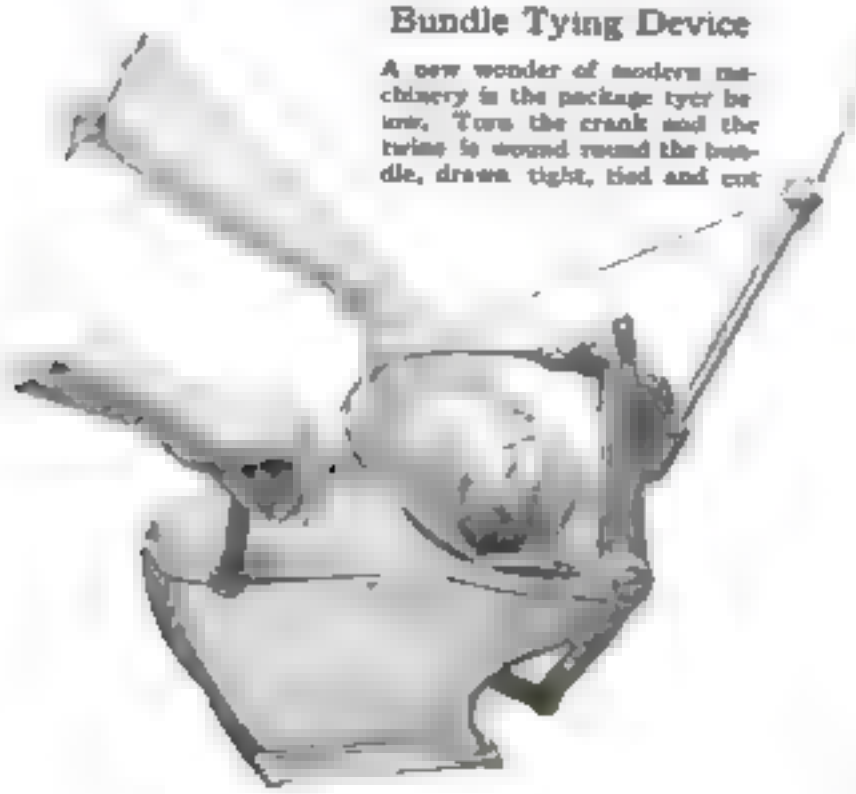
Those who don't relish glue will welcome the peculiar thimble-like device seen at the right, for moistening envelopes. At pressure of the fingers its spongy rubber end draws water from the small reservoir in the tube and then returns what is not needed for the envelope. The handle can be unscrewed very easily when refilling becomes necessary

New Light's Colored Rays Fight White Fog

W. E. C. Stone of Los Angeles, has developed for use of aviators a lamp whose varicolored beams contrast sharply with menacing vapor, making landing safer. A blending of selected metals in the reflector breaks natural colored electric light into its constituent colors, sending them broadcast over a wide area

Bundle Tying Device

A new wonder of modern machinery is the package tyer below. Turn the crank and the twine is wound round the bundle, drawn tight, tied and cut



Novel One-Wheel Luggage Carrier for Motor Cars

Less cumbersome than two-wheel trailers, and holding four times the baggage that ordinarily can be carried, this device, recently introduced in England, may be folded up when not in use. It is devised to fit any standard type of car

Old Maps Make Lamp Shades

QUAINT old maps, some of them used by generals in planning campaigns are now turned to a far different use by women who have them cleaned, varnished and built into lamp shades. Many make attractive pictures when framed.

In the photograph a final coat of varnish is being applied. The charted sections represent part of an area of Europe. The building at the left is the church

Fingerprints Identify Races

BY FINGERPRINTS the world's races can be roughly classified into West European, Italian, Indian, Japanese and Mandarin, recent investigators showed. Prints of persons of the same race were similar. This may help eventually to perfect the specific classification and subdivision of races.

Unique playing cards made of tiles, which remind one of Mah Jong and dominoes, add novelty to a bridge party and permit play on the porch or in the garden on a fair but windy day. They last forever

Playing Cards in Tile Form Defy Wind and Hard Usage

A NEW deck of cards in tile form, which borrows the traits of Mah Jongg, lets the hostess give her bridge party on the porch without fear of a sudden breeze disturbing the cards. Their solid construction prevents the wear that brings torn corners and cracked backs to ordinary cards.

The "cards" are packed in an attractive box which, as seen below, also provides individual racks for holding the "hands." The tiles are not dealt, but each player picks his own, as in dominoes.

Clock Times Life of Truck

HOW long can a truck run before it wears out? So owners may determine and thus know the actual cost of trucks in their business, a new clock like instrument has been invented. Attached to any moving part, it starts to register when motion commences and stops when the machine is idle. Its dial tells just how many hours up to ten thousand, that a truck, or for that matter any machine, has been run, regardless of the speed at which it operates.

The period of active use often sets the real life of a machine, instead of the days or months of off-and-on use. A huge cannon, for instance, must be relined after an active life of about three seconds, the time required to fire 150 to 200 shells.

Novel Saw Cuts 24 Piles in 50 Minutes

TWO minutes and "she's through"—with a new electrically driven chain saw that has been applied to pile cutting. Such was the time "clocked" for this heavy twenty-inch piling, and but fifty minutes was required to cut a row of twenty-four. Weighing only seventy pounds, this device, which promises great saving in dock work, is easily portable. A two-horsepower motor drives the saw.

The new two-horsepower chain saw that cuts off the top of a pile 20 inches in diameter in two minutes. It is portable, weighing only 70 pounds

Sky Plays with Sound Waves

FAR up in the air amazing things happen to sound waves. Dr. F. J. W. Whipple, of the Kew Observatory, England, found not long ago that sometimes he could hear a cannon sixty miles away eleven minutes after it had been fired, normally the sound would take less than half this time to cover the distance. At some nearer points the explosions were inaudible. Whipple suggests that sound waves are sometimes reflected back to earth from a warm atmospheric layer twenty-five miles or more above.

Know Your Car

A VARIETY of accidents can happen to your automobile that will cause trouble and expense, but there are forms of carelessness for which you may have to pay with your life.

Driving with weak or defective brakes is one of them. Failure to inspect the running gear and steering mechanism at regular intervals is another. You can't plead ignorance so far as poor brakes are concerned, because you can't drive any distance without knowing just how your brakes are working. So if you get into trouble with brakes, blame yourself.

That doesn't apply to trouble in the running gear and steering mechanism. Everything may work fine until some day, when you are speeding along a nice road, a loose bolt drops out and you are dumped into a ditch or plastered against a telegraph pole. Go over every bolt and nut in the running gear and steering mechanism regularly!

New Paint Striping Device Lets Anyone Decorate Auto

A NEW tool makes long practice unnecessary for automobile paint striping jobs. With one of these instruments, illustrated below, any striped design work may be duplicated by an inexperienced painter.

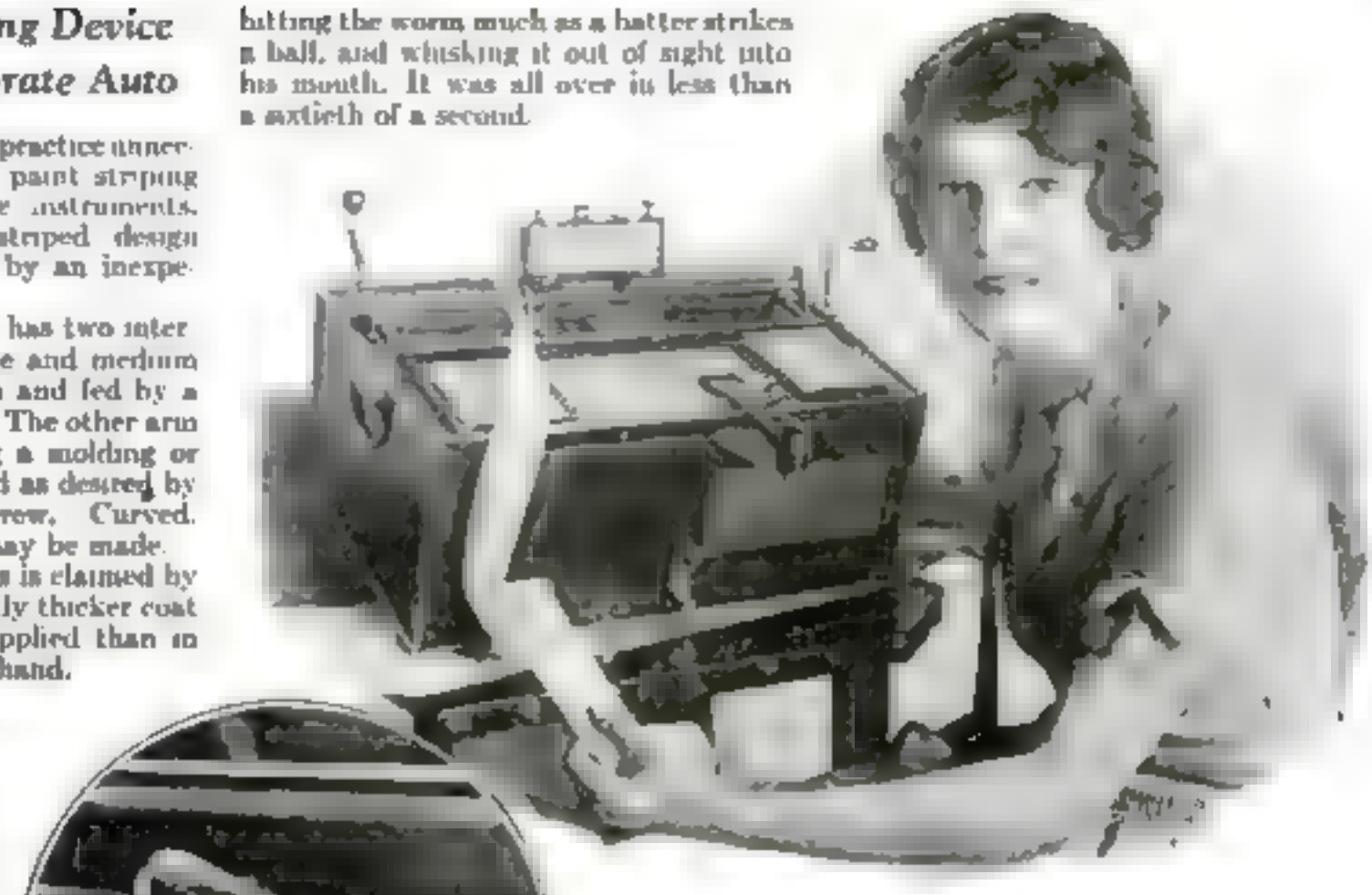
The compasslike device has two interchangeable barrels for fine and medium lines attached to one arm and fed by a rubber lacquer-container. The other arm is used for a guide along a molding or rule and stripes are spaced as desired by adjusting the thumb screw. Curved, straight, or design lines may be made.

Longer life of the stripes is claimed by the maker because a slightly thicker coat of lacquer is said to be applied than in the case of work done by hand.

Toad Challenges Camera's Speed

OFFICIALS of the London Zoo recently obtained the first movies of a Spanish toad swallowing his meal of a worm. A camera taking 1500 pictures a second was required! One taking 500 a second had completely missed the eating act.

When the authorities carried off their first film and developed it, they found they had good pictures of the toad, but between two of them the worm simply disappeared and how he went remained as much a mystery as ever. When they succeeded with the faster camera the film showed the toad's tongue batting the worm much as a batter strikes a ball, and whisking it out of sight into his mouth. It was all over in less than a sixtieth of a second.



The machine for painting stripes on motor cars (left) is in the form of a compass. One arm serves as guide, the other carries interchangeable fine and medium barrels from which lacquer is fed in even lines

How Much Do You Know of the World You Live In?

THESE questions are selected from hundreds sent in by readers. Test your knowledge with them. Correct answers are on page 168.

1. What is the northernmost town in the world?
2. What country is especially famous for its butter?
3. Where is fresh water found 200 miles at sea?
4. Where do men have their wives whipped by law?
5. Where does the abalone live?
6. What Alaska city is as warm as Philadelphia?
7. Where do goldfish come from?
8. What is a "dry lake"?
9. Where is there a lake of crystal soda?
10. What are the Antipodes?
11. Where are prayers burned instead of being said?
12. What became of the Temple of Solomon?

Tree Stump an Incinerator

THE question of what to do with old tree stumps has been almost as baffling as the time honored "What shall we do with our old razor blades?"

H. W. Ayers, of Burbank, Calif., made an incinerator out of one in his back yard which was so successful that neighbors were not slow in copying it. Ayers says he got the idea from a dream. The picture below shows him giving his novel and useful contrivance the finishing touches.

The refuse incinerator made from an old tree stump in his back yard, to which H. W. Ayers, of Burbank, Calif., is here seen applying the finishing touches

A Mechanical Professor

AND now we have the mechanical tutor, a portable professor, to be exact! It is a device that will teach you foreign languages, card games, and the like. If you would learn bridge, for example, all you do is place the arm with the squared indicator over the line of pictures illustrating that game and turn on the power. A phonograph attachment explains the points of the game as each picture comes to view. A synchronizing device makes this possible.

A. L. Runyon, a mechanical engineer of Los Angeles, invented the machine.

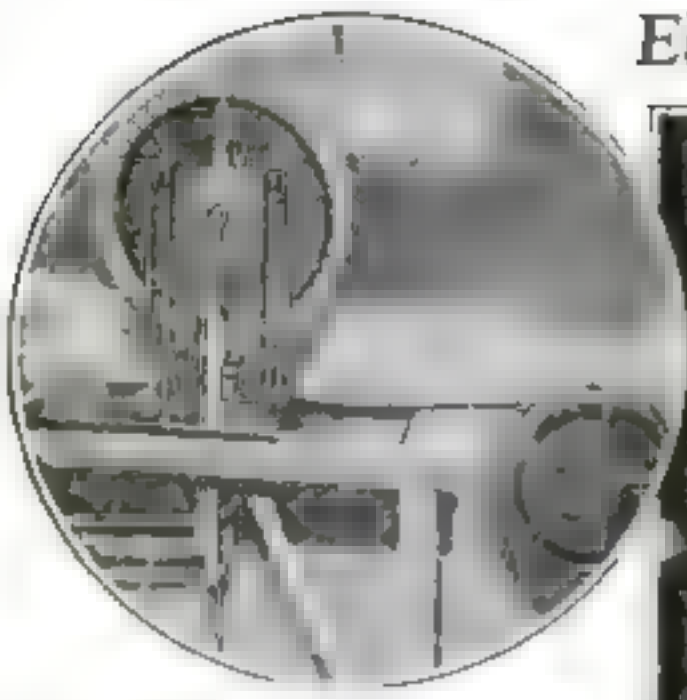
Cheap Cornstalk Walls Now

WALLBOARD made from cornstalks, a long-standing laboratory achievement, is now about to become a commercial process, thanks to six months' research by specialists of the U. S. Bureau of Standards. At present the huge corn crop is called the outstanding example of farm waste in the United States—less than twenty percent is used as food.

Last year Congress appropriated $30,000 for the Bureau of Standards to use in seeking to eliminate waste, as described in the May, 1927, POPULAR SCIENCE MONTHLY, by putting cornstalks, peanut shells, cotton burrs and cotton seed hulls to use. Now, after experiments, a plant for the manufacture of wallboard from cornstalks has been set up in coöperation with the Iowa State College, according to Dr. W. E. Emley, director of the research.

The experts have simplified the problem of extracting from peanut shells nonedible sugars valuable to the soft drink and tanning industries. These, it is expected, will soon be available to industry. Furfural, widely used to make synthetic resins, is promised by cotton-seed hulls. The tons of cotton burrs left unused by cotton gins still await a profitable use, though Dr. Emley says that all these wastes furnish a cellulose, from which artificial silk can be made.

Electric Signs Flash Paris News Bulletins



The machine that cuts stencil letters on the strip of heavy paper, spelling out the news bulletins to be flashed from tops of newspaper offices in Paris

Light bulbs turned on and off by a stenciled band passing behind them flash the letters of the stencils, giving Parisian crowds the latest news. The bulletin seen refers to the American Congress

AN INGENIOUS news-flashing system has been used of late by Paris newspapers to inform the boulevard crowds of the day's latest developments. The device resembles the running advertising phrases and time signals flashed in some of our larger American cities, but offers up-to-the-minute news which the operator receives by telephone and spells out on a lettered machine. This in turn stencils a heavy paper band that is run over the back of a frame carrying a bank of electric lights. Each bulb in the frame has a wire which causes it to light when touched by the stenciled letters, and thus spell out the sentences to those below

Sugar Produced by Chemistry

FOR years laboratory experimenters have sought in vain to duplicate the secret processes by which living plants form starch and sugar from sunlight, carbon dioxide gas absorbed from the atmosphere, and water taken in through their roots. At last, by an ingenious method, Prof. E. C. C. Baly, of Liverpool University, has succeeded

To water and carbon dioxide in a glass tube he added colored catalysts in the form of salts carbonate of nickel and cobalt. When the mixture was exposed to visible light from an electric lamp it produced substances that passed all the chemical tests for sugar

Professor Baly found also that growing plants may need the polarized light from the moon to convert into sugar the starch stored up in the leaves by direct light from the sun.

Heart No Pump, Says Doctor

THE accepted idea of the heart as an automatic pump sending blood to all parts of the body may have to be revised.

A famous German heart specialist Dr. Mendelsohn, says the heart is simply a governor to control the orderly flow of the blood, this current itself being due to the constant intake and outgo of liquid caused by chemical action in the body cells.

Dr. Mendelsohn says the heart, a small muscle the size of a man's fist, "could not possibly be capable of driving the tenacious mass of the blood through the entire body" He cites invalids with hearts so flabby as to release scarcely any energy, yet they lived for years with sufficient blood circulation.

The heart, he says, takes constant care that the blood flow be orderly.

Engineers' World News Service

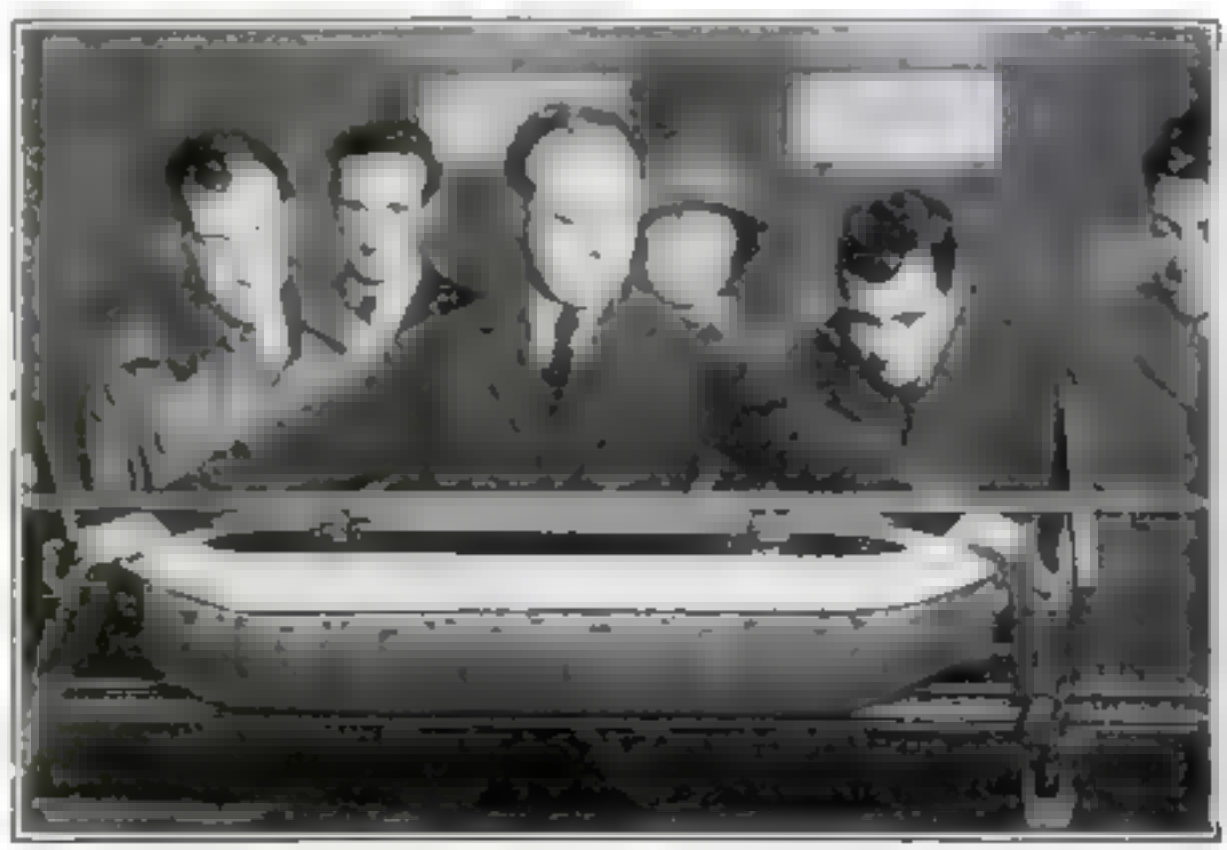
WHAT engineers are doing the world over is made available in a moment by a remarkable new service of the American Society of Mechanical Engineers. Libraries and other subscribers receive each week a batch of index cards to be filed in a special cabinet, bearing titles and abstracts of articles on engineering problems that have just appeared in American and foreign technical papers.

For those who have restricted interests, cards bearing only information on their subjects are supplied. More than a thousand publications of thirty-seven countries are digested for the subscribers

Monorail Cars under River

MONORAIL cars will scud at sixty miles an hour beneath the River Tyne on a new type of underground railway seen below, designed by E. W. Kearney, British engineer, if his plan, already passed by the Ministry of Transport, is approved by Parliament. First of its kind, the tube is to connect North and South Shields. Along the middle of its floor will run the angle rail that supports the weight of the novel subway cars a guide rail above keeps them from toppling and completes the electric circuit by which they receive power

By eliminating swaying and jolting, the track design permits high speed the inventor says. Stations will be elevated above the tube level, giving cars a "running start" downgrade and automatically slowing them at the other end. This is said to result in a great saving in power, and reduction of jolts and wear



E. W. Kearney, British engineer, exhibits model of the monorail cars with another rail above to steady them and supply electrical power, which he expects to run in a tunnel beneath the River Tyne

Cement Mine a 40-Acre Mushroom Farm

Farming by torchlight under the ground is the business of Howard Bell, who is seen here with a gasoline flare, tending some of his forty acres of mushroom beds. This unique large scale gardening operation goes on in an abandoned cement mine, where the temperature is ideal for mushrooms

ONE of the strangest farms in the world is the great subterranean acreage of Howard Bell, of Crittenden, N. Y., on which he raises huge crops of mushrooms. Seeking means to cultivate the delicacy, which thrives without daylight, on a wholesale scale, Bell conceived the idea of using an abandoned cement mine. The results were even better than he anticipated.

Throughout the entire underground agricultural plant a temperature of from forty-seven to fifty-one degrees is maintained the year round, thus being ideal for the product.

Little light is used in the operation of the unique farm of forty acres. Bell tends his plants with the aid of gasoline or other artificial illumination. None of the mushrooms in his beds ever sees sun.

Thousands of persons grow mushrooms in cellars for their own use or for market. Bell has many thousands of cellars in one.

"Coldest Spot" Is 452 Below

THE coldest spot on earth is a new laboratory in Berlin, to study strange changes that take place in substances exposed to temperatures as low as 452 degrees below zero—within about eight points of absolute zero! This is done by liquefying helium gas under high pressure, then allowing it to expand.

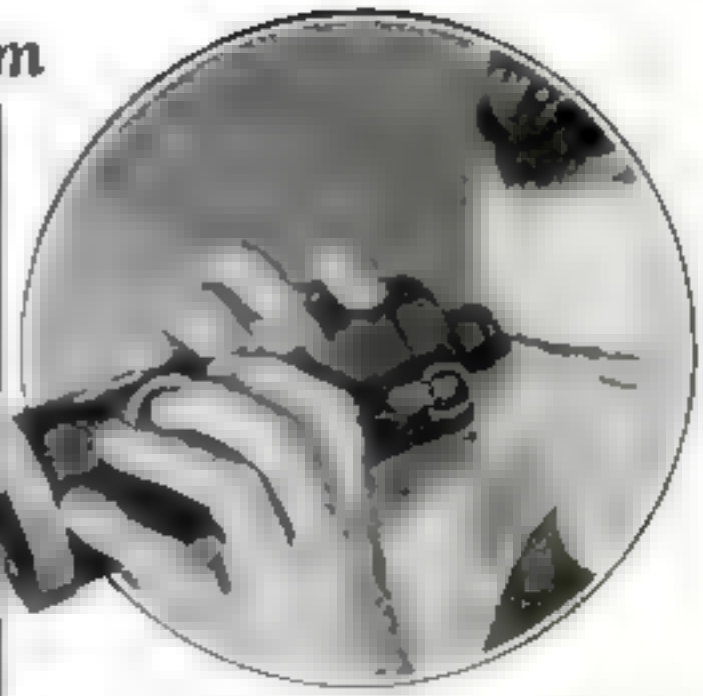
At such a temperature some metals, such as silver and copper for example, lose their resistance to electricity, becoming super-conductors. A thread of frozen mercury, it is said, can carry enough electricity for several hundred lamps

Phone Insulators' Bath Day

TELEPHONE line insulators in the Salt Lake Desert, Utah, have a regular wash day to remove salt blown from near-by beds, which cakes on the glass and causes leakage of electricity.

Steam is sprayed over the insulators from a nozzle on the end of a fish pole. Though an agreeable action on the glass results, B. F. Howard, engineer of the telephone company, says the economy of the method he has developed justifies it.

Washing the caked salt off telephone insulators with a steam nozzle on the end of a fish pole on the Salt Lake Desert. At right the mobile plant that supplies steam of eighty to ninety pounds pressure, oil being used in heating of the efficient boiler



Optical Device Gages Heat

EVEN the blistering heat of molten metal pouring from a furnace can be measured conveniently and accurately by a new instrument resembling a small telescope. When it is pointed at the glowing stream, the brightness of the reflection seen through the eyepiece is taken to indicate the temperature. Through an adjustable dial this glow is compared with that of a small electric flashlight bulb within the device, and the exact number of degrees directly indicated when the two are matched through a red sighting glass.

This simplified optical pyrometer, as the device is called, will measure accurately the temperature of a glowing body only a quarter-inch in size ten feet away! Unlike types that record electrically the heat of a fire, as sighted through a furnace door, this instrument can test the temperature of pouring metal and of small bodies not inclosed.

Why Boys Eat So Much

IF YOUR son puts away a bigger meal than you yourself can eat, don't be surprised, advises the Bureau of Home Economics of the U. S. Department of Agriculture. He is merely behaving like any normal, active boy of nine to eighteen. At certain ages boys and girls may need one to one and a half times as much protein and mineral matter as adults, according to a new dietary scale worked out by the Bureau that gives the needs of each member of the family.

Do Radio Waves Never Die?

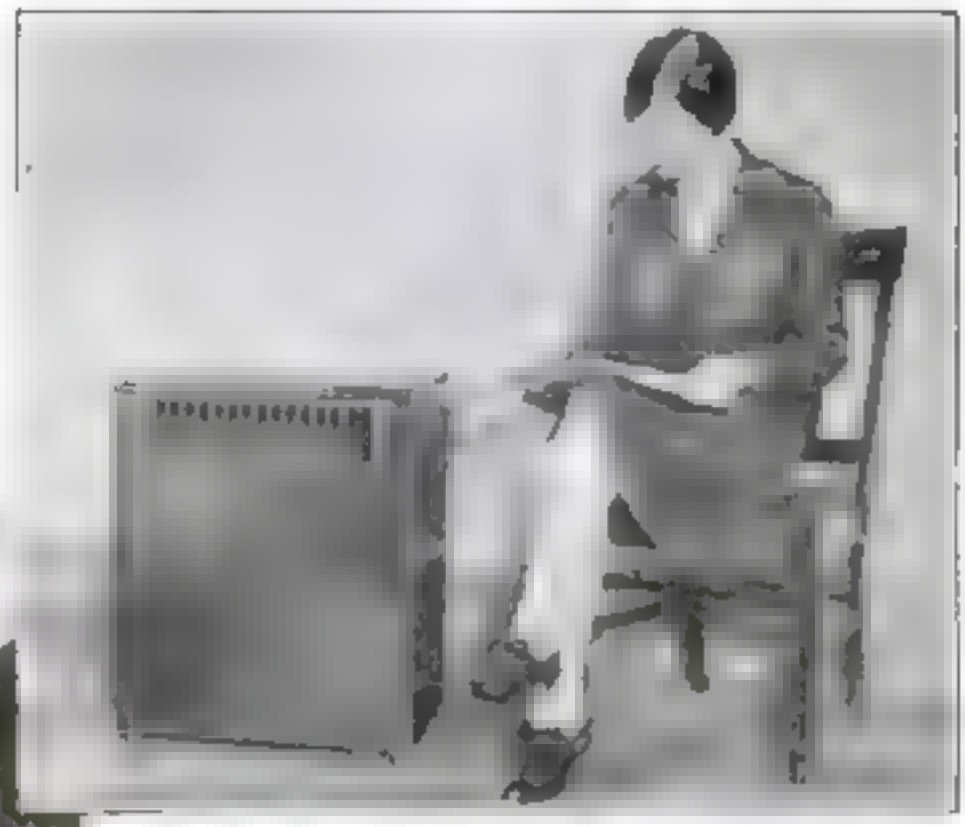
THAT the voices of famous present day men, transformed into radio waves, are now wandering around the earth and may be picked up a century hence is the startling contention of engineers of the Marconi Company, London. Such waves, they say, never die out completely; with sensitive enough receivers they might be heard in 2028! Already they have heard programs that have circled the world three times.

Commenting on the idea, Dr. Lee de Forest, inventor of the vacuum tube, said, "Theoretically the waves exist forever, as do those of the ocean. The splash made by Noah's ark is still in existence. Radio waves are too weak to be recorded by existing receivers even a few minutes after their emission."

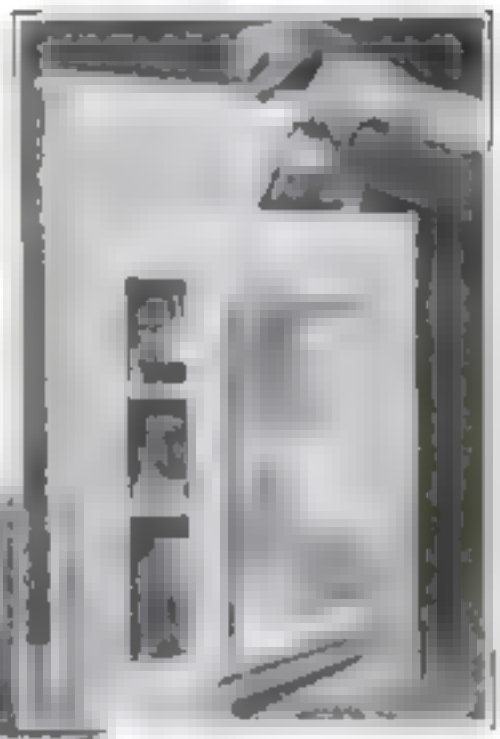
Inventors' Ideas Add to

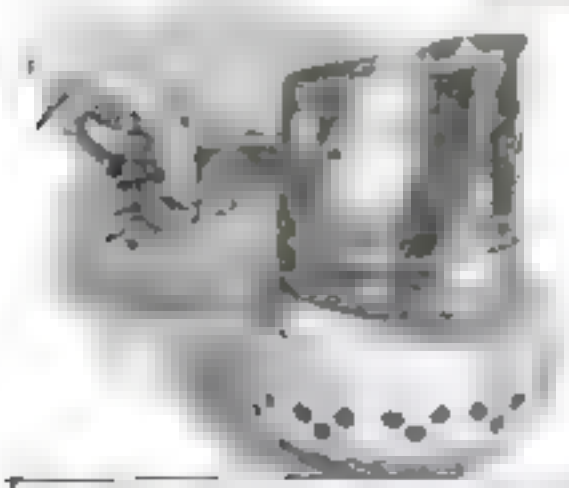
Putting a keen edge on the carving knife or other cutting utensil becomes easy for the housewife with a new grinding wheel which is clamped to the kitchen table. The grinder is belted from a hand wheel to give high speed with minimum effort. A guide attachment aids in holding the knife at the correct sharpening angle

Here's a new, one hand flour sifter that leaves your other hand free for mixing dough or beating batter. When you squeeze the hinged grip, an agitator whirls back and forth over the sifter's wire bottom and speeds the flour on its way. The operation is rapid and convenient



Steam heat produced by electricity and ready at the turn of a switch is the feature of a new portable heating cabinet. The little radiator need only be plugged into a wall or lamp socket. It is so light that it can be moved on casters from room to room as desired





A new idea in mechanical burglar alarms is a large gong bolted to the door knob so that when the knob is turned the gong instantly arouses the entire household. No batteries nor electrical connections are required

No danger of accidentally removing a bottle of poison, in the dark, in mistake for another, from a new folding medicine cabinet pictured above. It has a separate compartment at the top for the poisonous substances

A London hotel keeper to avoid discarding worn brooms entirely, invented this clamping device by which new brushes can be attached to the old handle. It also permits a brush to be reversed and the other side used after one side has become worn thin

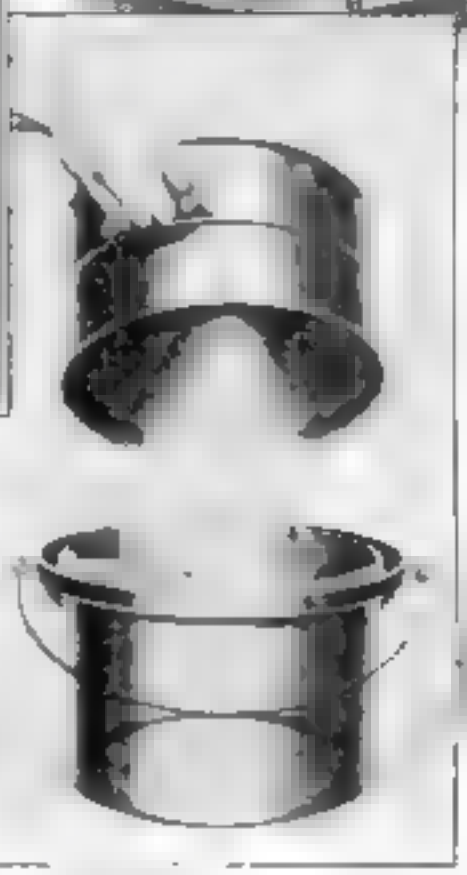
Johnnie won't know where the cookies are kept for a while, at least—if they're placed in the secret top compartment of the bread and pastry cabinet at the left. Both of these are portable cabinets, folding to fit into a small space

In filling a narrow water pan humidifier located behind the radiator it is usually difficult to keep from splashing the wall or floor. To make the task easier, this special funnel has been devised. It is of large diameter, with an unusually long neck that makes the water pan readily accessible

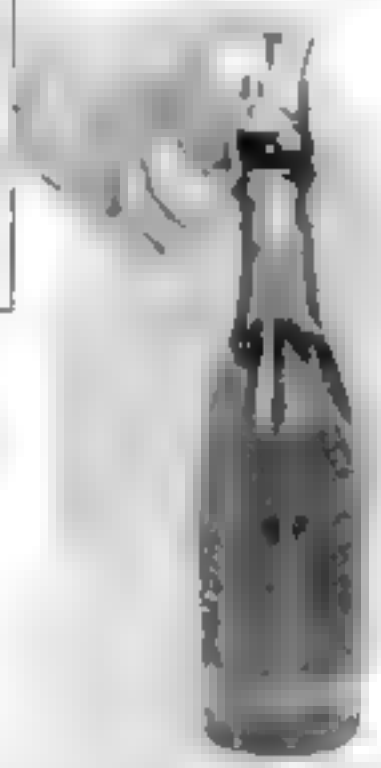
Home Comfort

Provided with two drawers and a spacious top surface, a unique new inclosure for the ordinarily unsightly radiator serves as a useful desk or library table. Heat is radiated through a grating below the drawers, but the construction is such that magazines, books, or writing material may be placed inside without damage from the heat from the radiator

Foods are cooked from the inside out, it is said, by an amazing new electrical apparatus that can fry an egg in two seconds, or bake a potato in sixty seconds. The novel device is a high-power development of the radiant heater which is used for medical baking



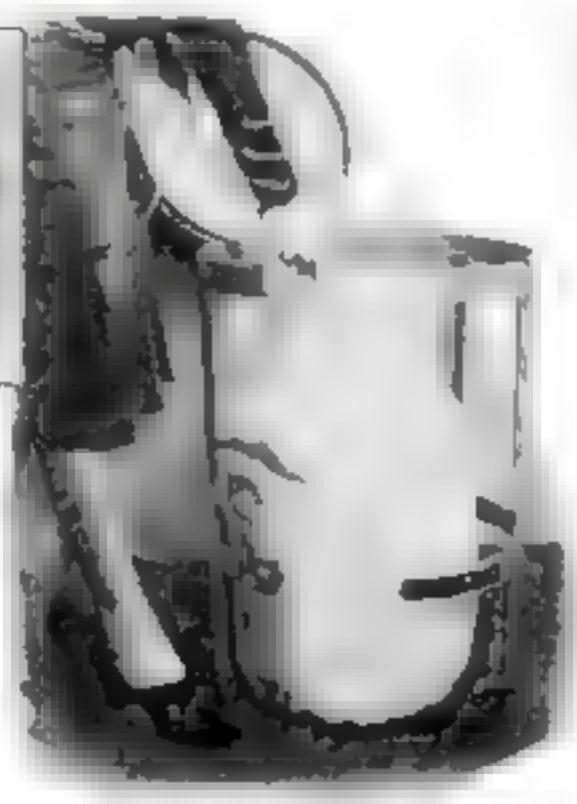
When the funneled lid of this new cooker is filled with cold water, it prevents escape of liquids from food being cooked, by condensing the steam as it arises. The top part is lifted off to put in food



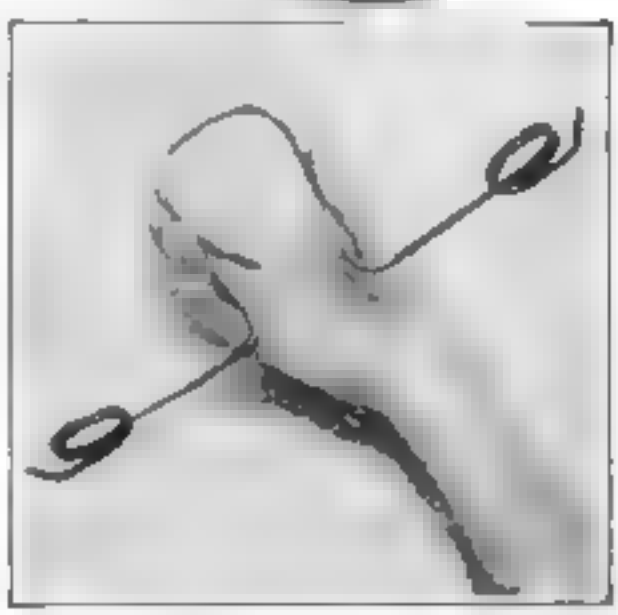
The bottle stopper attachment below not only keeps the fizz in half filled bottles of ginger ale or charged water, but converts them into syphons. A slight pressure on the knob at the top discharges the contents of the bottle

Suspended from the wash line as shown at the left, a new clothespin bag saves stooping for pins. The bag slides along the line, always within reach of the one hanging the clothes

The inventor of these scissors claims they need never be sharpened. An occasional right-hand turn on a small adjustment screw regulates the tension in such a way that the blades sharpen themselves. No screw driver is needed to do it



While one laundry bag is at the laundry, the other may be placed securely in this convenient holder to receive soiled clothes. The hinged frame opens to receive the container or permit its removal; no lifting is required. Throwing back the hinged lid and loosening the clasp is all that is necessary to open it



It's easy to take the sag out of old upholstered chairs and make them as good as new, it is said, by the use of a new type of spring designed to give them new life. A set of the springs can be attached beneath the old seat in a few minutes

Locating *Your* Radio Trouble

Here an Expert Tells How to Build and Use Inexpensive And Effective Apparatus to Test Your Set When It Fails

By ALEXANDER SENAUKE, E.E.

TROUBLE shooting, as practiced by the average radio fan, consists mostly of shooting in the dark.

Suppose that some evening the set goes dead. You test the batteries and find them all right. Then you look over the wires to the batteries and find nothing wrong. After that you raise the lid of the receiver and note that all the tubes are lighted. So far you have pursued the search for trouble in the approved fashion, but from there on you spend a lot of time shooting in the dark, hoping that you will be lucky enough to stumble on the trouble in time to ward off a visit from the radio service man.

You take the tubes out of the sockets and polish the ends of the prongs. You make sure that the spring contacts in the sockets are in good shape and then you begin an aimless prodding around inside the receiver with a piece of wood or the end of your fountain pen. Sometimes you find a loose wire that is the cause of all the trouble but if you have no such luck, then what do you do? The chances are you give it up as a bad job and phone for the repairman to come up and fix the set.

BUT you don't have to give up so quickly. It's quite easy to learn how to service your own set when something goes wrong and incidentally earn a reputation among your friends as an expert radio trouble shooter.

In previous articles in POPULAR SCIENCE MONTHLY we have outlined the simpler things you should do when the set goes dead, such as testing the batteries, looking for poor contacts and making the other investigations that are possible without the aid of special apparatus. Now we want to show you how to go several steps further either with laboratory apparatus suitable for the purpose or by means of simpler and less expensive home-made apparatus.

The first principle of radio trouble shooting is to take nothing for granted. Don't consider that a single thing about the radio set is as it should be until you have definitely proved by adequate test that it really is all right. Don't assume, for instance, that the storage A-battery is charged just because the tubes light. They often glow at a temperature just below the heat that makes them effective and then you will be fooled. Nothing but a hydrometer test of each individual cell should satisfy you that nothing is wrong with the battery. And even then a poor connection in the A-battery wires may be preventing the current from getting to the tube filaments.

Similarly, don't assume that the antenna is in good condition and the ground connection firmly made, merely because they were right last week or last month. Personally inspect them to make sure.

Possession of what is known as a laboratory type test set, such as is shown in use in Fig. 1, will put you in a position to find out at once the most vital information about any radio set, and that is the condition of the tubes. It also will enable you to eliminate at once many possible sources of trouble.

In Radio Trouble Shooting—

"Take nothing for granted, prove it by testing," says Mr. Senauke, who is the assistant director of the Popular Science Institute of Standards.

"Test batteries first, then tubes, then hunt broken connections or poor contacts.

"Avoid aimless poking around; follow each circuit from one end to the other.

"One broken wire will render a set completely inoperative. One dead tube will kill reception.

"Never prod around inside the set with anything made of metal."

Fig. 1. This circuit tester, with a small flashlight battery inside, will instantly reveal an open circuit and will show on its dial the amount of resistance

The vacuum tubes, as you know, are the supremely vital parts of your set. All of the other parts are there merely to permit the tubes to function as they should. And the filament is the heart of the vacuum tube. When heated to the proper temperature it sends out the stream of electrons that makes the tube perform its task of amplifying the radio signals received by way of your antenna. They allow it to rectify and thus detect the signals so that they are put into a form suitable to be heard by the human ear and without a constant flow of electrons from their filaments, vacuum tubes used as audio amplifiers could not amplify by many hundreds of times the extremely weak signals passed on from the detector tube.

OF COURSE, you can't make yourself small and crawl inside the vacuum tube in order to count the billions of electrons as they fly off from the heated filament through the grid and to the plate of the tube. But you can accomplish the same result by measuring how much current rides across between the plate and the filament on this stream of electrons. This is called the plate current and it is taken from the B-batteries or the B-eliminator, depending on how the set is equipped.

The test set measures this plate current. It also enables you to tell, merely by turning a knob or pressing a button, the voltage of the plate current as it actually is applied to the plate of the tube.

Obviously, if the meter shows that ninety volts is being applied to the plate of the tube, you can be sure that the wiring of the B-circuit for that particular tube is right clear back to the B-battery or B-eliminator.

THE test set also shows the actual filament voltage applied to the filament of the tube being tested. If you find, for instance, that the filament voltage is five, you know with absolute certainty that the storage battery is right and that the A wiring is right, and you can cross these off your list of possible sources of the trouble.

Another turn of the knob or the pressure of a different button and the

meter shows the C-voltage being applied to the tube and tells you at once that either the C-circuit is in order or that something is definitely wrong.

In other words, when you put the test plug in the socket in place of the tube and place the tube in the socket provided in the test set, you can instantly tell whether the tube is good; whether the A, B and C voltages are correct for the tube and if these circuits are working as they should. Merely by turning a knob or pressing different buttons you eliminate at once the possibility of trouble in the majority of places where troubles can occur.

By placing the test plug in each socket in the set you accomplish in a minute as much testing as could be done by the tedious testing of the individual circuits one at a time.

HOWEVER, laboratory type test sets, which cost about $75.00, are somewhat beyond the means of the average radio fan, although one should be a part of the equipment of any professional radio service man worthy of the name.

But even if you can't afford such an elaborate piece of apparatus, you can build yourself a test set for about seven or eight dollars that will be amply accurate for your purposes, even if it does not equal the precision of the special test sets.

The circuit of such a test set is shown in Fig. 3. The meter is a Weston No. 301 reading from 0 to 7 volts D.C. The fixed resistance R is 15,000 ohms. In addition to these parts you will need a double pole, double throw switch, an ordinary bell push-button, a vacuum tube socket, two binding posts and a special dummy plug that you can make out of a base from a discarded vacuum tube.

Mount the apparatus on a board or fit it to the top of a cigar box with the wiring inside. You can make it just as elaborate or as simple as you want. To construct the dummy tube plug, break out all the glass and cement in the base and solder the G and F wires to the prongs that make contact with the G and F springs in a vacuum tube socket. Fit small pin jacks or spring wire clips to the two filament prongs, which are the two thick prongs on the base of any modern X-type tube. The object of this arrangement of the filament leads from the test set is to allow you to reverse them if you run into a set in which the plus wiring is to the minus terminal of a socket.

TO USE the test set you have built, plug the dummy plug into the socket in place of the tube you wish to test, placing the tube itself in the socket you have in the test set.

Throw the switch to the left and the meter will read the filament or A-voltage actually being applied to the tube terminals. This should be very close to five volts for a 201A type tube. If it is over that figure, the rheostat is turned too far. If you can't get it up to five volts by turning the rheostat, then either the storage battery is dangerously low or there is a poor connection somewhere in the A-circuit or the A-battery wiring.

Now throw the switch to the right and the meter will tell you the amount of plate current flowing through the tube. One volt on the meter will be equivalent to 2.3 milliamperes of plate current. The plate current depends, of course, on the plate or B-voltage and on the C-voltage. If the plate voltage is ninety and the C bias is four and one half, the plate current should be two and one half milliamperes. If it is below one and a half milliamperes the tube is poor and should be rejuvenated or replaced by a new one. If the plate voltage is ninety without any C bias the plate current for a good tube should be about six milliamperes. If below four, discard or rejuvenate.

Fig. 2. Testing a radio receiver by means of a laboratory type test set. This device gives facts about condition of tubes for guidance in correcting trouble

TO determine the plate voltage, leave the switch thrown to the right and take the tube out of the socket in the test set and then press the button. The meter will now read the voltage of the plate or B-circuit as applied to it by the B-batteries or B-eliminator. Each volt division will be approximately equivalent to thirty-five volts on the plate, so that if the hand stands at slightly less than three on the scale the B-voltage is ninety, or if it points to six it is 180.

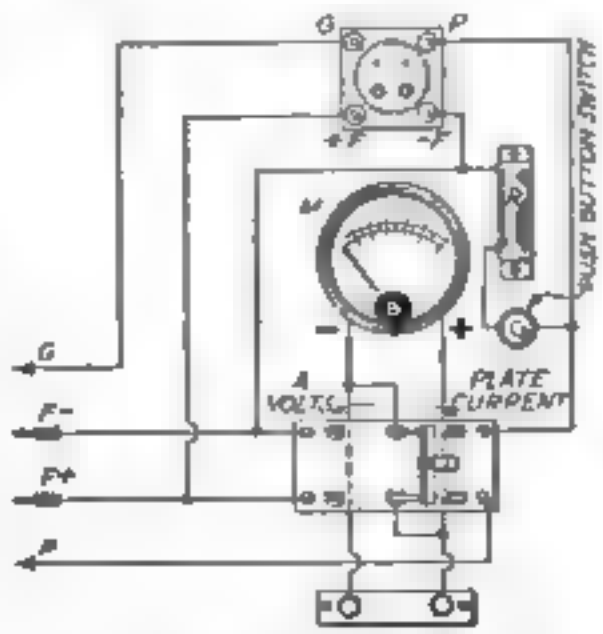


Fig. 3. The circuit of a home-built test set—not so accurate as the laboratory model of a service man, but good enough for most fans

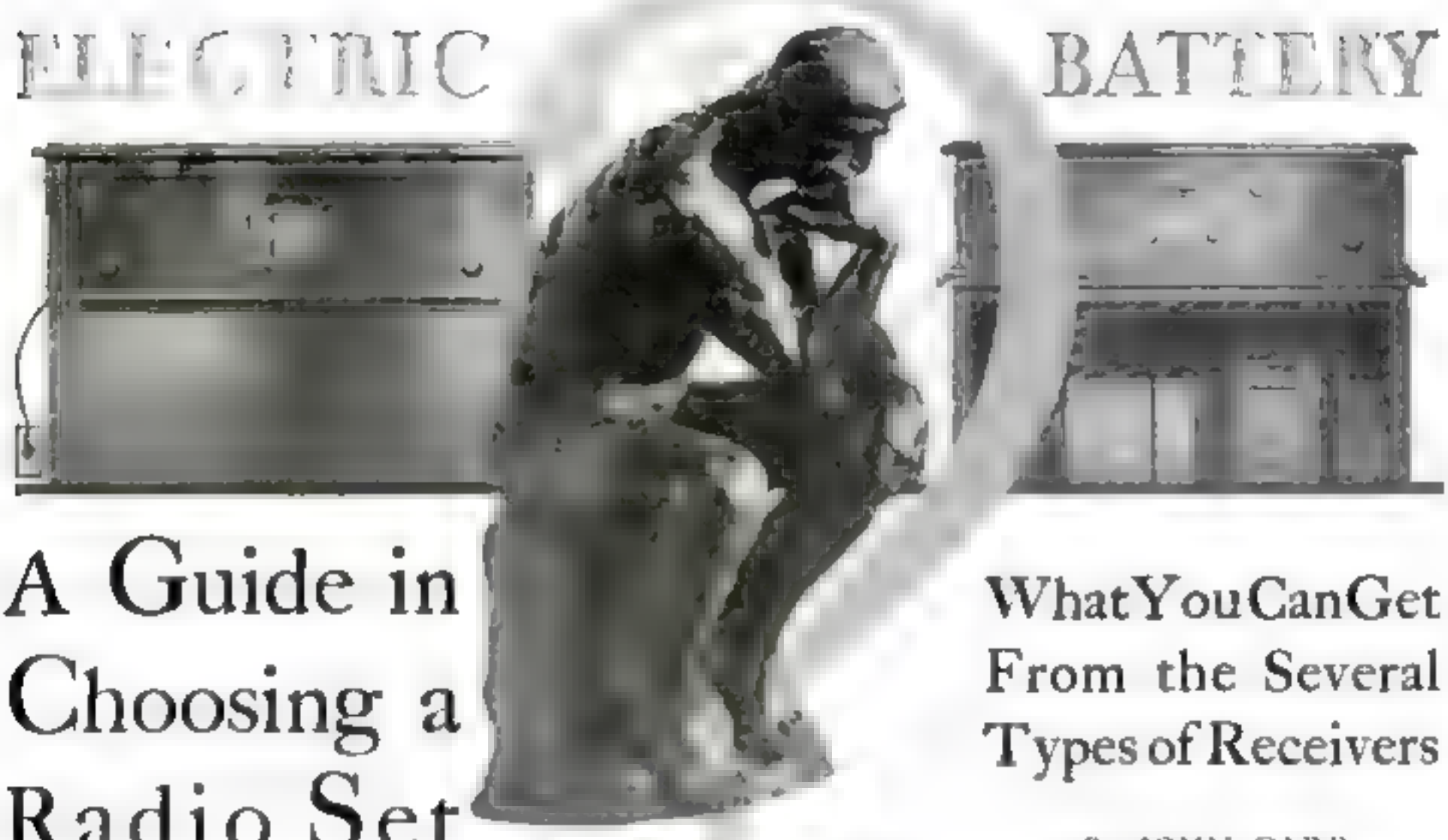
The test set cannot be arranged to show the C-voltage without rather complicated switching, but you can test the C-battery directly by connecting it to the two binding posts with the switch in the open position.

These two binding posts also serve another useful purpose. By connecting them in series with a four-and-one-half volt C-battery and any portion of the circuit in the radio set not already proved up by the tests already outlined, you can definitely determine that the circuit is complete. If the meter does not read, the suspected circuit is open at some point. If the meter reads, you can be absolutely certain that there is a continuous metallic circuit. If the circuit being tested is just a few feet of wire with some connections and perhaps one of the tuning coils, the meter should read the full four and one half volts developed by the C-battery. If the circuit includes a fixed resistance of any value beyond a few ohms, or perhaps the primary or secondary winding of the audio transformers, the reading will be considerably less than four and one half volts.

A METER designed for testing the continuity of any circuit and showing its approximate resistance is shown in Fig. 1. Such an instrument is a valuable addition to the equipment of any man engaged in radio testing as a profession, but for home purposes the simple arrangement heretofore mentioned will suffice.

A small flashlight cell is fitted inside the meter, so that no additional batteries need be used. The dial is calibrated in degrees, and there is a table printed on the lower part of the dial so that you can determine the approximate resistance of the circuit as well as whether the circuit is continuous or not. This feature enables you to check the value of the various fixed resistances in the receiver or the power unit. In using a special meter of this type, or in testing circuits to see that they are not broken by means of the home built test set diagrammed in Fig. 3 with the aid of a four-and-one-half-volt C-battery, remember radio circuits often provide several paths between two given points. For instance, you might touch one wire of your test circuit to the filament terminal of a socket and the other to the wire running to the terminal. The meter would show a continuous circuit even if the wire did not make contact with the socket terminal. The current from the four-and-one-half-volt battery would flow between the two points by way of the tube filament in the socket being tested or through the filaments of other tubes connected in parallel with it.

WHILE most of the troubles that beset a radio receiver show up at once in poor tone quality or some other obvious form, there is one that affects neither tone quality or volume. If the C-battery supplying a power tube gives out so that the voltage drops below where it ought to be, the tube will still work well, although its life will be materially shortened. Never operate a power tube, particularly the 171 type, at lower than recommended C-voltage.



A Guide in Choosing a Radio Set

An Article Approved by The Popular Science Institute of Standards

What You Can Get From the Several Types of Receivers

By JOHN CARR

WHEN is a radio receiver an electric set and when is it not? Which is better a battery set or an electric set? Must the "socket power" "electrified" full electric set get from the socket and all the other new radio terms actual amount?

If you speak of an electric automobile you mean one operated by electricity and perforce one operated by electricity from storage batteries. Logically you would think that the term electric radio receiver would mean one operated by electricity but as there is no such thing as a radio receiver operated by anything else "electric" has been given a new and quite arbitrary meaning as applied to radio.

Broadly speaking, an electric radio receiver is one that operates without batteries. That is about as near as you can come to defining the term "electric" as it applies at present to radio receivers. What it may mean six months or a year from now nobody can tell, since it had no such meaning in the first place and is now being widely, loosely, and often erroneously used.

The terms "electrified," "socket power," "direct from the light socket" are merely various people's ideas of correct terms for outfits that fit in somewhere between the battery operated set and the so-called electric set.

TO CHOOSE intelligently among a battery operated set, an electric set and the combinations in between, you must know the essential differences among them.

Of course if you have no electric light current in your home you are out of it so far as an electric set is concerned. Your problem is to choose from among the battery operated sets the one that meets your requirements. The same is true if you are in a district where the current supply service is erratic and the voltage fluctuates to a serious degree. In certain outlying districts the lights get quite dim during the early evening hours when everyone is using current and they may be extra bright late in the evening after most people have gone to bed. An electric set can be used on such a line but the results are liable to be just as erratic as the current supply.

But if you are located where the light current service is reasonably steady you have a wide choice of equipment all designed to get the same results, that is, adequate reception of broadcasting. And if you choose good apparatus you will get the desired results equally well, whether the set is battery operated, partly electrified or full electric. There should be no difference in actual radio reception between a battery set and an electric set. They can be equally sensitive and equally selective. There is no choice for tone quality. The only difference is in the amount of attention and care required.

MAKE sure that you have alternating current of the proper voltage and frequency before you invest any money. If your current is not 110-volt sixty-cycle or if it is direct current you will need special equipment.

When you are buying your radio equipment forget all the high sounding terms and find out just what you are buying and how it operates, and read the instructions that accompany the equipment.

Note particularly what, if anything, you have to do at periodic intervals. The ideal of course is a set that requires absolutely no attention beyond the occasional replacing of a tube that has gone dead.

Don't let anyone fool you into believing that there is a radio receiver which operates directly on the raw 110-volt alternating current just as it comes from your light socket. Such a receiver has never been produced and probably never will be. Direct current in the B and C circuits of a radio receiver are absolutely necessary, and consequently no A C radio receiver that operates without batteries has a B-eliminator tucked away inside it somewhere. This B-eliminator is to all intents and purposes exactly like the B-eliminator you buy to use in place of dry cells on a battery operated receiver.

THE A circuit is another story. In the electric set there are three distinct methods used to accomplish the results attained by the storage battery in the ordinary battery operated receiver.

The simplest and most widely used method is to employ special so-called A C tubes that can be operated directly on raw alternating current after it has been stepped down from 110 volts to a suitable low voltage. This usually is accomplished by an extra winding on the transformer in the built in B-eliminator.

There is no mystery about these A C tubes. The 226 and similar type tubes are exactly like the regular 201A tubes except that they have a very thick filament that has a low resistance and consequently will operate on a very low voltage, about one and one half volts. The filament heats relatively slowly and doesn't fluctuate in temperature with the rapid changes in the flow of alternating current. These tubes could just

(Continued on page 142)

He Rebuilt His House *and* Saved $6000

How a 60-Year-Old Residence Became A Modern Home—Hints You Can Use

By JOHN R McMAHON

North end front side of the Penka house before (small upper photograph) and after it was made over. Half of the spacious inclosed porch is used by the tenant family by occupying the first floor of the house the other half is used by the Penkas, who make their home above

"I AM going to buy that old house on the hill and fix it up in a way you never heard of," said my friend Joe Penka about a year ago.

"Put it on wheels and take it to Florida in winter?" I hazarded.

"No, although I do have a piece of land down there. My scheme is to make it a combination of a one-family and a two-family house, so that it can be used either way on short notice."

"That sounds fairly original, but what is the object?"

"I want to live in the house myself," explained Joe, "because it is a nice location several hundred feet back from the road fine view and everything but it is too large for my family of four I like company and wouldn't mind sharing the house with another family That means adding a few rooms and putting in duplex conveniences. But suppose we change our minds about sharing, or my family increases, or somebody offers a good price for a one-family residence? With my scheme it wouldn't take more than a week to change the layout either way."

"There are difficulties," I observed. "For example, both sets of folks will want the front porch. Perhaps a movable partition is the answer

"NO, I'LL divide that porch with an imaginary line," said Penka. "It isn't practical to divide a kitchen with an imaginary line, but you can a front porch if the people concerned are at all congenial and friendly."

"You may be right, and if it doesn't work it will be the fault of the other family," was my comment. "But how about the architectural lines of the house?"

"They're terrible now, aren't they? Look queer on every side except the front and that isn't much to boast of. There's a two-story box gummed onto the back, and beside it a little storm porch like a chicken coop—and another shed on the opposite side. The open front porch with its long spindly columns takes a lot of space and gives no service except in summer But some of the lines are good and I rather like the pointed arch windows that you don't often see today The rounded triangle windows for the attic are interesting and the wide overhang of the roof with the prominent cornices appeals to me Now my idea is to replace the rear additions with a one-story structure that will match or balance with a similar glassed in front porch. Then the house will harmonize with itself and will look well from any side."

YOU need a good architect, and he may charge you a thousand dollars."

"I expect to be my own architect" said Joe. I have a college diploma as a landscape architect—and the principles of landscaping and house designing are a good deal the same—proportion, harmony and contrast. And of course I learned a good while ago how to make scale drawings, which is no great trick, although many carpenter-builders shy away from them."

JOSEPH PENKA is one of those men who belie the proverb that a jack-of-all-trades is master of none. There is at least half a scientist in his makeup. After working in a greenhouse, he launched into market gardening on borrowed capital, originated a disease-proof lettuce, and within a few years made a modest fortune. He sold out to invest in a laundry and a public garage. Before tackling the job described in this article he had built a house and remodeled two.

"To make radical changes in an old building is a proposition always followed by a question mark. All kinds of unforeseen difficulties may develop. Who knows whether the inside material is sound? In this case a careful survey convinced the owner that the job was worth while. The house was about sixty years old, which meant, in this locality at least, good materials and stanch construction. Due attention had been paid to upkeep. Oak and white pine were the choice elements of the original dwelling, nor were these timbers skimped in all dimensions according to modern style.

The entrance hall showed the proudest achievement of the old builder, a flight of stairs with a solid walnut balustrade that did not terminate at the second floor

An imaginary line divides the two-family inclosed porch of the house that Joseph Penka made over. Mr. and Mrs. Penka are on opposite sides of the line, which runs through the doorways the families share

East side of the made-over house showing, at the left, the kitchen of the first floor tenants and at the right their half of front porch, divided from the owner's by an imaginary line. Note improved appearance as compared with picture at right

East side of the 60-year-old house before it was made over. Note the cold, unsheltering front porch and the unsightly lean-to "gummed" on to the rear

West side of the old house, whose good lines were deprived of their effects by the unsightly front porch and rear additions before they were replaced with improvements that contributed to the symmetry of the whole structure

West side of the two-family home in its new guise. Its originally sturdy construction made it worth while to chuck the old front porch and the additions at the rear, and build the inclosed porch, left, and the kitchens, one of them seen at the right

but curved gracefully around to protect the opening above. Such a balustrade is a rarity and could not be duplicated today for less than a thousand dollars.

There were four rooms downstairs and the same number up. The rotation plan called for a division along the line of the main stairway, giving the owner all the upper rooms, of which one would become a living room and another a bath, with a part of the new first floor rear addition as an alternative sun parlor-kitchen and half of the new front porch. The other family, quartered entirely on the first floor, was to have living room, dining room, two bedrooms, kitchen and bath. All would share the front entrance, the owner having an extra side entrance to the front porch.

THE scheme required a glassed in front porch fourteen by thirty-six feet and a rear addition of the same size for two kitchens, one regular and the other convertible to a sun parlor. Plumbing was simplified by two sinks on either side of a partition. The bathrooms were not located with the same economy, although there is a common waste pipe in the cellar.

The layout of space indicates no dining room for the owner! However, there is room for a dining alcove in the wide light main hall under the stairs, not to mention the sun parlor-kitchen.

When a builder asked $12,000 for the job, Joe decided to be his own contractor. It took him a year of more or less steady work to make all the changes, and the cost was about $6000, figuring his own labor at $3500.

"A contractor figures ten percent over estimated actual cost on new work, but he doubles the ante on an alteration job so as to allow for all unexpected troubles and costs," said Joe. "In this case he would have had no troubles and would have cleared a couple of thousand dollars."

ALL but the inside plastering and electrical wiring were done by the versatile owner. The outlay for these items with outside help was around $700 apiece.

To extend the old cellar beneath the new additions did not seem necessary, but concrete foundations to a depth below frost were made along the new lines. A cellarless construction with double floors and building paper between, is satisfactory in mild climates at least, but good ventilation is imperative, for woodwork in a confined damp space is subject to rapid decay. In this case vents were placed in the outer foundation walls and windows were inserted in the cellar walls so that in summer air might sweep under the entire house.

The framing of the new sections—floor joists, rafters and studs—was done in fir, which compares favorably with oak for the purpose. Studs and joists were spaced according to the usual modern standard of sixteen inches between centers, rafters, twenty inches. Sheathing boards of yellow pine and then building paper were applied.

To match the old style white pine clapboards for the outside wall, spruce was used. If spruce is not the equal of white pine in exposed positions, it still ranks high in resistance to decay and if kept painted will endure as long as anything else that you might use.

MOST of the original interior trim downstairs was left in place, while fir and white pine were selected for new trim.

"I covered all the floors, new and old, upstairs and down with oak," said Penka. "The old boards had shrunk, leaving cracks where dust and dirt settled. No air came through the cracks from below because the boards were tongue-and-groove, yet cold could get through. A double floor with paper between layers is warmer than a single floor. It is stiffer, does not sag or creak. Also, white pine is too soft to stand much direct wear.

"I used white oak, sawed flat grain, (Continued on page 148)

Your Own Building Problems

WHAT has been your experience and the experience of your friends in building and rebuilding houses? What problems confronted you and how did you meet them? What problems do you face now? Write the answers to these questions to the Home Building Department and Mr. McMahon will make your experiences the subjects of his new series of articles about real houses of real people, of which this is the first. Letters should be addressed to Home Building Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York

Nothing is apt to cost so much as a Bearing that cost so little!

It costs more to replace a poor Bearing than to buy the best that SKF ever produced

LET'S get right down to this matter of bearings and consider them, not on the basis of their purchase price, but on the basis of *cost* price. For cost price is the thing you pay.

It does not profit a man much to buy a bearing because the price is low and then actually *pay* more for lubrication, adjustments, repairs, than if he had bought the best bearing in the world

It does not profit a man much to buy a low-priced bearing if a valuable machine goes out of service just because the bearing could not stand up.

All of which supplies the reason why you will find SKF Anti Friction Bearings on most quality products from the small, fractional horsepower motor to the giant turret lathe or heavy duty railway passenger car.

For SKF on a bearing, like the sterling mark on silver, represents a definite standard of quality and you can depend on one just as surely as you can depend upon the other.

SKF INDUSTRIES, Inc., 40 East 34th Street, New York, N. Y.

SKF

Ball Bearings Roller Bearings

1955

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When You Buy a Car—

Beware of the Big Trade-in Allowance and the Service Graft, Says Gus

By MARTIN BUNN

"As a matter of fact, you're both right. Each of you has picked a car that I would have recommended"

"WHAT'S the matter with your car?" Gus Wilson asked his partner Joe Clark as the latter arrived one morning on foot.

"I could answer a lot easier if you'd ask what isn't the matter with it," Joe grumbled as he hung his hat and overcoat on the door of the tiny office in the Model Garage. "I'm afraid the time has come when I've got to dig into the old bank roll and get me a new car."

"It's about time," Gus chuckled. "I've been wondering how much longer you were going to keep that old wreck."

"I could fix it up easy enough if I wanted to," retorted Joe.

"Sure you could," Gus agreed. "No car ever gets so old that it can't be put in good running order—if you're willing to spend money; but there comes a time when its parts begin to lay down one after another and it doesn't pay to try to fix it. You've had your money's worth out of your car; now you'd better turn it over to the junk man. What kind of a car are you thinking of buying?"

"Whoever will give me the biggest allowance on the old bus gets my order," replied Joe. "You say all cars are about alike, so I'm going to shop around and see how much money I can save."

"And probably get stung doing it," predicted Gus. "I declare, Joe, you certainly don't show much sense sometimes. When did I ever say that all cars are exactly alike? What I said was that any modern car will give good service—and that's all I meant. Some cars are much better buys from a price point of view than others. And you'll generally get the biggest allowance offers from the dealers who sell the worst bargains.

"THE dealer who has the hardest time selling his cars usually is the most liberal with trade-in allowances. Besides, some manufacturers put a fictitious list price on their models just so the dealers can make bigger allowances. The thing to do is pick your car first and then find the dealer who'll give you the best allowance. Hello! What's that?—"

Gus broke off suddenly as the front door of the garage closed with a violent smash.

"I tell you you're cuckoo!" growled an angry voice from the shop. "That car's a lemon if there ever was one!"

"G'wan! You don't know what you're talking about!" came another equally heated voice.

"More grief!" whispered Gus, after peeping out the office window. "It's my cousin from up Winchester way. Another morning shot to pieces! Hello, folks!" he called out as he snapped the last buckle on his overalls and stepped out into view. "What's all the row about?"

"Well, you see it's this way, Gus," began one of the two as he fished a bundle of automobile catalogues and circulars out of his pocket. "Ben and I have decided to buy new cars this spring and I've been trying to get Ben to take my advice but he's so darn pig-headed he won't do it."

"Pig-headed, am I!" exclaimed Ben. "Maybe I am—because I know I'm right—but your dome sure is made of solid concrete—"

"THAT'S no way to start a visit," interrupted Gus, "but I suppose the argument is what brought you here, so let's go in the office and get it settled.

"I gather," he continued when they had settled themselves around the table with the literature spread out before them, "that you've each chosen a different make. What cars are you thinking of buying?"

"I could pretty near have guessed right on both of you," Gus smiled after they had belligerently announced their choices. "You still working in the tool room at the Manley works, Hank?" he inquired, turning to the man who was wearing the flannel shirt.

"You bet," Hank replied. "I'm foreman now."

"And you, Ben, I suppose, are still the leading legal light of Winchester?"

"I'm still practising law," Ben corrected him.

"HAVE it your own way," grinned Gus. "Anyway, each of you is an expert in one particular line. But you've driven all the way down here just to get my opinion on a line that neither of you is expert in—automobiles.

"The car you've picked, Hank, is fast. It's got lots of pep on the hills. It doesn't ride any too easy unless you fit it with shock absorbers and keep them adjusted just right. The motor will give good service if it gets just the proper care, and there are a number of other things about the car that require touching up every now and then if you want good service. But, balancing the advantages against the disadvantages, I'd say it was a mighty fine car."

Hank grinned triumphantly. "Told you so!" he snickered.

"On the other (Continued on page 138)

A Radiotron for every purpose

RADIOTRON UX-201-A
Detector Amplifier

RADIOTRON UV-199
Detector Amplifier

RADIOTRON UX-199
Detector Amplifier

RADIOTRON WD-11
Detector Amplifier

RADIOTRON WX-12
Detector Amplifier

RADIOTRON UX-200-A
Detector Tube

RADIOTRON UX-120
Power Amplifier Tube

RADIOTRON UX-222
Screen-Grid Tube
Radio Frequency Amplifier

RADIOTRON UX-112-A
Power Amplifier

RADIOTRON UX-171
Power Amplifier Tube

RADIOTRON UX-210
Power Amplifier Tube

RADIOTRON UX-240
Detector and Amplifier

RADIOTRON UX-213
Full Wave Rectifier

RADIOTRON UX-226
Amplifier

RADIOTRON UY-227
Amplifier

RADIOTRON UX-280
Full Wave Rectifier

RADIOTRON UX-281
Half Wave Rectifier

RADIOTRON UX-874
Voltage Regulator Tube

RADIOTRON UV-876
Ballast Tube

RADIOTRON UV-886
Ballast Tube

The standard by which other vacuum tubes are rated

Look for this mark on every Radiotron

Every Radiotron is tested and inspected in 41 different ways before it is approved in the laboratories and factories of RCA, General Electric and Westinghouse.

The Radiotron is the joint product of RCA, Westinghouse and General Electric, developed and perfected in the same great laboratories which give you the MAZDA lamp. They are the creation of the skilled radio engineers who made modern broadcasting possible. Equip your set with genuine RCA Radiotrons. Never use new tubes with old ones that have been in use a year or more. See that your set is completely equipped with RCA Radiotrons once a year at least.

RCA HOUR
Every Saturday Night

Through the following stations associated with the National Broadcasting Company

8 to 9 p. m. Eastern Time
WEAF WBAL
WEEI WRC
WTIC WHAM
WJAR KDKA
WTAG WLW
WCSH WJR

7 to 8 p. m. Central Time
KYW WDAF
KSD WOW
WCCO WHAS
WOC WSM
WHO WMC
WSB

8 to 9 p. m. Pacific Time
KPO KFI
KGO KGW
KPOA KOMO
KHQ

RCA Radiotron

MADE BY THE MAKERS OF THE RADIOLA

RADIO CORPORATION OF AMERICA · NEW YORK · CHICAGO · SAN FRANCISCO

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Kinks *That Will Help* Your Car

Auto Convertible into Bedroom—Garage Doors That Close Themselves—Handy Quick Acting Jack—Other Good Ideas

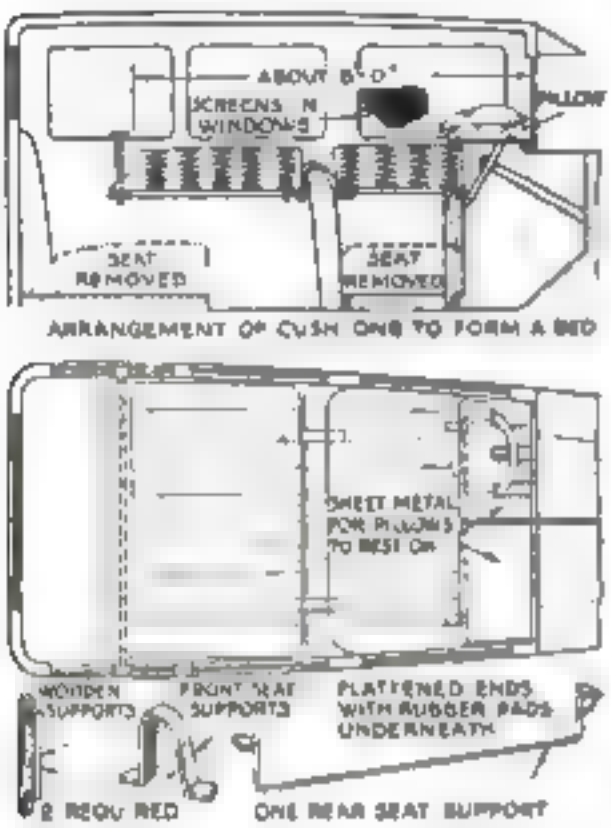

Fig. 1. Seat cushions can be made to serve as a mattress in camping. Screen two windows

A Bed in a Motor Car

HERE is an ingenious way to utilize the regular front and rear seat cushions of your closed car as a bed while auto camping. As you will note from Fig. 1, you will need to construct one long bracket to support the rear end of the rear seat cushion. The ends of this bracket rest on the rear window sills to fit a rubber pad on each end of the bracket. The two brackets that fit over the back of the front seat are heavy strap iron. If the front seats are divided you will need four brackets, two for each front seat. Wooden supports hold the front edge of the front seat cushion and a sheet metal support for the pillows completes the bed. A long roll-shaped cushion can be fitted into the space between the front and rear cushions if desired.

A Quick-Acting Jack

WHILE the regular style of jack that you usually carry in the tool kit is, of course, adequate for emergency tire changes on the road, you will find that a simple quick-acting jack such as is shown in Fig. 2 will save a lot of back-breaking work in the home garage. The materials you need to construct this jack are an old crowbar, a piece of heavy three-inch pipe, a long half-inch bolt and two five-inch iron wheels. Ordinary crown pulleys will do nicely. The upper end of the pipe is rounded to fit the axle. Be sure to drill the hole for the crowbar at the proper angle. Then when the crowbar strikes the ground the wheels will have rolled just past center under the axle.

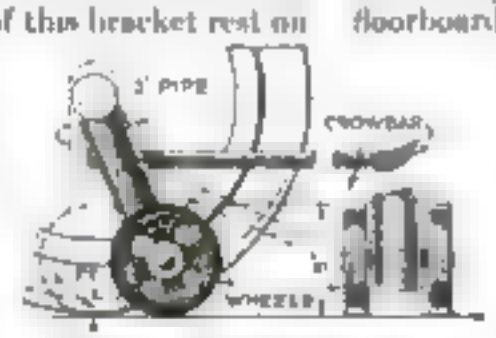

Fig. 2. Simple jack made of an old crowbar, a bolt and pulley wheels

Back Through Garage Doors!

OPENING the garage doors, driving out and then having to get out of the car to shut the doors after you is a nuisance when you are in a hurry. By constructing garage doors after the fashion shown in Fig. 3 you will be able to back right through the doors, and they will close after you, eliminating the necessity for getting out to close them by hand. As you will note from the drawing, a rope or cable is arranged over pulleys so that swinging the lower half of the door down automatically raises the upper half. You will have to work out the locations of the pulleys to suit your own garage. Be sure that the lower half of the door is built strong enough to stand the weight of the car and use counterweights to assist the closing with rubber bumpers to take up the jar.

Tool Boxes in the Floor

IN LONG trips it is difficult to find room for extra tools. Fig. 4 shows how to solve the problem. If you will take up the floorboards in front of the rear seat you will find that there is plenty of room for at least one deep tool box and one shallow one. The latter is necessary to clear the exhaust pipe. Make the boxes of galvanized iron riveted together at the seams. Remember that the body with the tool boxes drops down much nearer the axle when the car goes over a bump, and allow plenty of clearance. The illustration also shows a neat arrangement

Fig. 3. Construction of garage doors that will close themselves after you have backed out

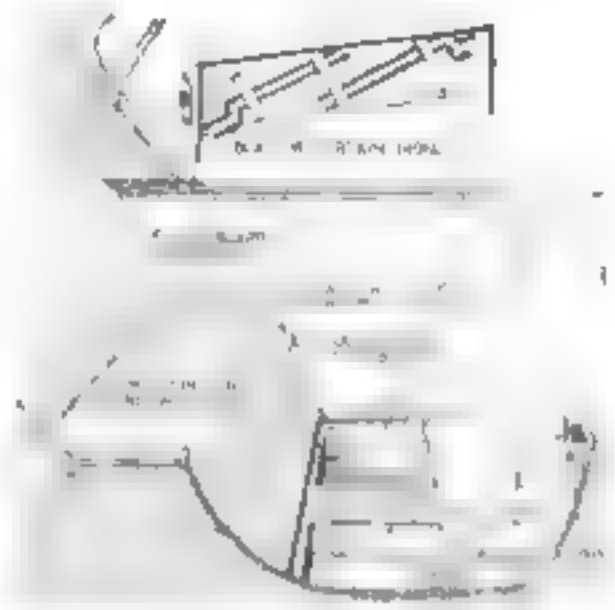

Fig. 4. Extra compartments for tools and odds and ends can be fitted under rear floorboards

for packing the curtain irons. The shallow tin box for small tools to slip under the driver's seat, also shown in the drawing, is particularly good for closed cars of the coach type, where the front seats tip forward.

Swinging Stop Light

MOST cars sold today are regularly fitted with stop lights, but here is a way to make yours more effective than the standard. Look over Fig. 5. In place of the regular stop light fit a board, and to the top of it attach an ordinary vacuum type windshield wiper. Replace the wiper with a lightweight tail-light. The rubber hose should be run to a valve on the dash board and the other side of the valve piped to the intake manifold of the motor. The bulb in the swinging stop light should be wired to the regular stop light switch, operated by the foot brake.

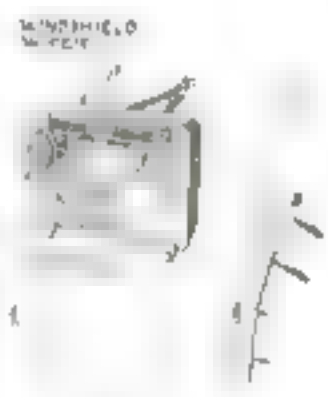

Fig. 5. A swinging stop light commands immediate attention

Ten Dollars for an Idea!

P. H. ASHBY, of Strathcona, Alberta, Canada, wins the $10 prize this month with his garage door suggestion (Fig. 3). POPULAR SCIENCE MONTHLY awards $10 monthly, in addition to regular space rates, for the best suggestion for motorists. Other contributions published are paid for at usual rates.

ANNOUNCEMENT 1928

SALE of the BRITANNICA LOW Price!

equaled and unrivaled. From time to time, other publishers have tried to make cheap imitations of it, in a dozen different languages, but these have died out after one or two editions because none of them could stand comparison with the Britannica.

A Wonderful Work that Cannot Be Imitated

There has always been something in the spirit of this great work, handed down from one generation of editors to another—some splendid spirit of foresight and thoroughness and impartiality and nobility of purpose—that imitators could never copy.

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The Encyclopaedia Britannica is the *only* work of reference that has an entire volume devoted to an *Index*—an index which cost more than $150,000 to produce. This remarkable Index volume, with its 500,000 references, gives you complete command of all the rich resources of this comprehensive work. It is like a huge magnifying glass which enables you to pick out, in a moment's time, the vital knowledge that you must have. A reference work without an index is often absolutely useless. The information *may* be there, but you can't find it. That is never true of the Britannica, which places all the knowledge in the world at your command for *instant* use.

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Before you risk a dollar of your good money, you can prove to yourself that this is an opportunity you cannot afford to miss.

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The Simplest Flying Model

Anyone Can Build Successfully This Little Single-Stick Monoplane

By J. D. BUNCH and A. F. KOCH

The success of commercial aviation tomorrow lies with the youngsters of today. From among them will come our successful designers, manufacturers, promoters and flyers. The national miniature aircraft tournament conducted by the Playground and Recreation Association of America will help direct this enthusiasm in a practical way and will help insure the future air supremacy of the United States.
—Commander Richard E. Byrd.

THERE is a real thrill in flying airplane models. It doesn't matter how old you are or whether you know anything about aviation or not, you can't escape the fascination of the game. But first you have to get into it, and to do that we can think of no better way than to build the model illustrated.

Known as a hand-launched single-stick tractor monoplane, it is one of the simplest yet most interesting models. It can be made more quickly than almost any other type of plane and the cost for materials is trifling. It is, nevertheless, an excellent flyer.

Building the model is much easier if you have full size drawings of the various parts. These you can obtain by sending for POPULAR SCIENCE MONTHLY Blueprint 82 (see page 106). The experienced model-maker knows well the value of having large drawings to work from, for the beginner they are even more essential, for he has either to draw his own full size layouts, which is often the hardest part of the work, or take advantage of blueprints such as those published as an auxiliary service for readers of POPULAR SCIENCE MONTHLY.

The fuselage of this model is a single stick of white pine ⅛ by ¼ by 30 in. This must be straight grained and sand-papered to a smooth finish.

First the propeller shaft bearing is installed. This may be purchased from a model supply company or you can make it from a ½ in. long piece of ⅛ in. inside diameter brass tube with 1/32 in. thick wall. The tube must be flared slightly at the front end so it will not slip back through the threads. Cut a block of white pine ⅛ by ¼ by ½ in. and groove it along the top to make a cradle for the bearing. Glue it to the top of the fuselage and bind the bearing in place. Before the glue dries, true the bearing up along the fuselage.

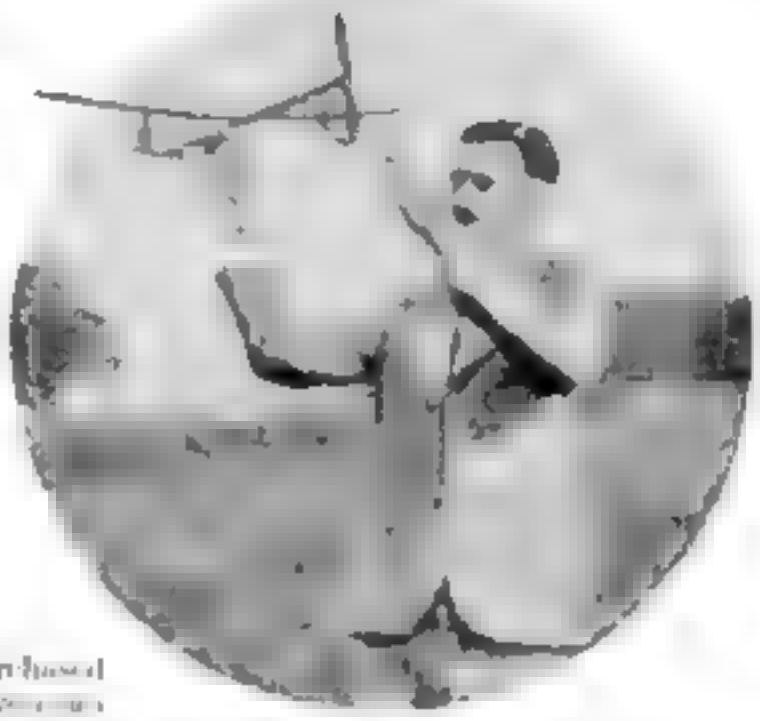
Make a rear rubber hook as shown and bind it to the fuselage.

The skid, or propeller guard, is made from a piece of bamboo ⅛ by ⅛ by 7 in. It is bent, as shown, around the tip of the propeller, then up to meet the fuselage 3¼ in. from the nose, and then parallel to the fuselage for ¾ in. Glue and bind the skid to the underside of the fuselage. The skid brace, or front leg, is ⅛ by 1/16 by 4½ in. It is bent parallel to the fuselage at one end and to the skid at the other. It should meet the skid 3½ in. from the fuselage and should meet the fuselage 1½ in. from the nose. It is bound in place and glued.

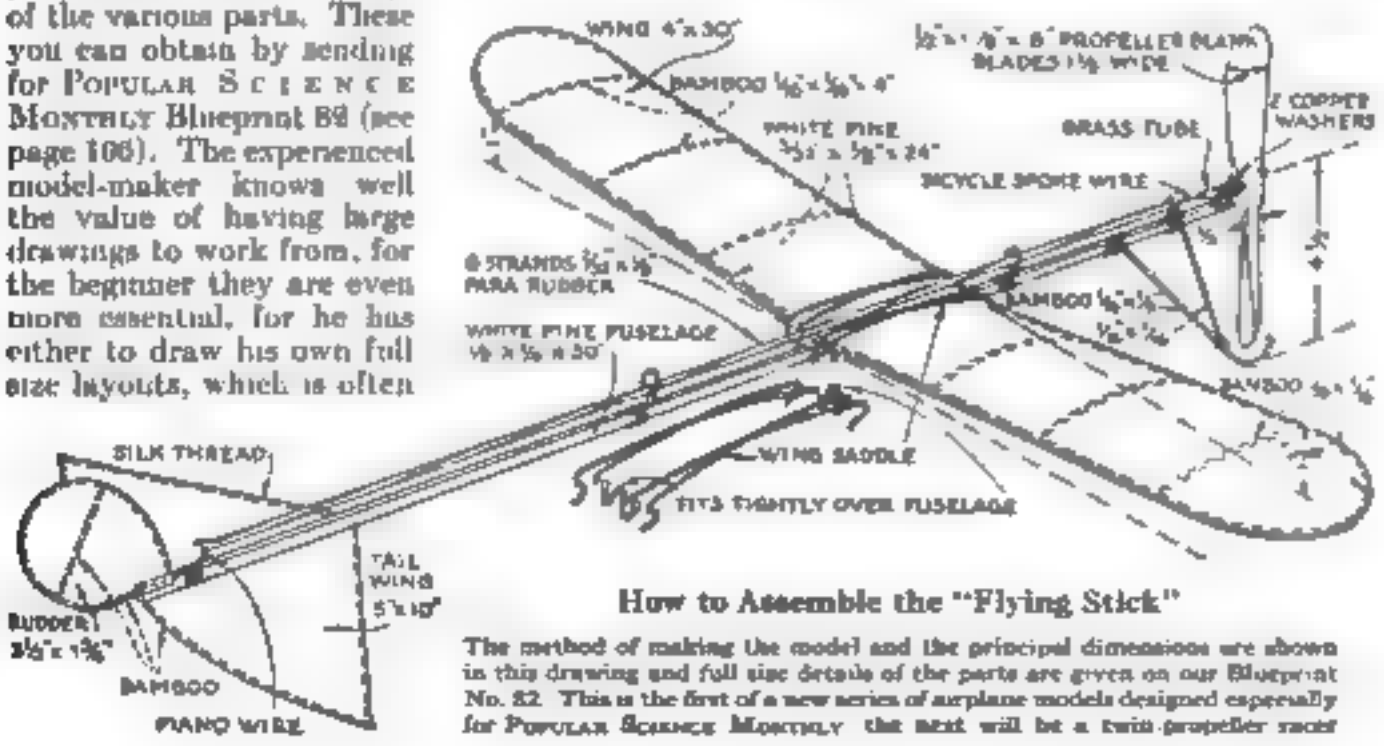
Bamboo is bent by heating it over a candle and forcing it into the desired curve. Hold it that way for a moment until it cools. Whenever possible, bend bamboo with the glossy side on the outside of the curve.

The "cans," or rubber guides, which keep the strain of the motor from distorting the frame, are made of ½ in. diameter piano wire. There are two of these, one 7 in. and the other 18 in. from the nose. Loop the wire into a ring ½ in. in diameter, bend the ends parallel to one another for ½ in. and then bend them at a right angle to the loop for ½ in. Glue and bind the cans to the fuselage.

The tail wing is fitted to the under-side of the fuselage. The spar is bamboo ⅛ by ⅛ by 10 in. It (Continued on page 126)



Koch shows how to hold the 30-in. model when launching it. Both he and Bunch fly large as well as small airplanes, for they are commercial aviators



How to Assemble the "Flying Stick"

The method of making the model and the principal dimensions are shown in this drawing and full size details of the parts are given on our Blueprint No. 82. This is the first of a new series of airplane models designed especially for POPULAR SCIENCE MONTHLY; the next will be a twin-propeller racer

Powering Your Electric Set

How to Complete the New Popular Science Receiver with an Amplifier and Current Supply Unit Giving Maximum Volume

By ALFRED P LANE

IN THE February issue of POPULAR SCIENCE MONTHLY we described the construction of a new electric radio receiver. To complete this receiver you will need to build either the high power amplifier and current supply unit to be described here or the lower powered and less expensive unit to be described next month.

This amplifier is the most powerful one you can assemble with apparatus now available to the home builder It uses two ⅡO tubes in a push-pull circuit, and the volume without distortion will equal that of the band playing in the studio, provided, of course, that you use a good loudspeaker The tone quality is superb. Low notes come through without thumping or rumbling, and the entire useful musical scale is reproduced so that musical instruments or voices sound natural and lifelike even at tremendous volume

The construction of the amplifier and current supply unit is shown clearly in Figs. 2 and 4, and the wiring in Figs. 1 and 3.

In order to eliminate the possibility of magnetic interaction between the power transformer, the choke coils and the push-pull transformers, the instruments have been spread out on a long, wide baseboard.

THE complete electric set, consisting of the receiver described last month (Blueprint 79) and the power unit described here, is designed to fit into a standard factory made console type cabinet or into the console cabinet made at home from Blueprints 70 and 71 The receiver fits in the upper compartment and the power unit in the lower one ordinarily used for batteries.

The first step in the construction is to make up the baseboard. The one used on the unit shown in the illustrations is 12¼ in. wide and 26 in. long. This is as large a baseboard as can conveniently be gotten into the lower compartment of the console cabinet chosen for the set. Crosspieces should be screwed to the bottom of the baseboard at the ends and in the middle to add strength and to allow room for passing some of the wires underneath the baseboard. Before fastening these pieces on the baseboard, be sure to drill a row of holes through them so that the wires can be passed through from one end of the unit to the other.

Blueprint Is Ready!

ORDER Blueprint No. 80 (see page 106). It will prove helpful in building this new high power amplifier and current supply unit. Many of the lesser details are included on the blueprint that could not be given here for lack of space. The Popular Science High Power Unit for Electric Radio Set and the receiver itself (Blueprint No. 79) have been tested and approved for home construction by the Popular Science Institute of Standards.

The three binding post panels can be made of shellacked plywood or from bakelite or hard rubber They are mounted by means of long screws that pass through the small wood supporting blocks

You will need these parts to build the high power amplifier and current supply unit for the Popular Science Electric Radio Set

A Power transformer with 1½-volt 2½ volt, two 7½ volt windings and a 750-volt winding tapped at 500 volts.
B1 4 Choke coil, 20 henries at 125 mils.
B2 4 choke coil, 30 henries at 30 mils.
C1, C2, C3, C4, C5 and C6 2-mfd. condensers rated at 1000 volts direct current working voltage.
C7—1-mfd. condenser rated at 600 volts.
C8 and C9—1 mfd. condensers rated at 100 volts.
D1 input transformer
D2 output transformer.
R1 —41,000-ohm heavy duty fixed resistance, tapped at 32,000, 21,000, 10,500, 12,500 and 8,000 and rated not less than 40 mils.
R2—1000-ohm fixed resistance rated to carry not less than 50 mils.
R3 —25,000-ohm fixed resistance
S1, S2, and S3—standard X-type vacuum tube sockets.
Eight binding posts, flexible enameled fabric-covered wire, 1 UX-281 rectifying tube and two UX-210 amplifying tubes.

IT IS not necessary to use a baseboard made of one single piece of wood The crosspieces permit you to assemble the baseboard from several pieces. The model power unit shown in the illustrations has a baseboard made up of three pieces which are firmly held together by screws through the crosspieces. Use boards ⅝ in. thick. The parts are heavy and should be strongly supported.

Study the illustration in Fig. 2 and the picture wiring diagram of Fig. 3. They will show you how to place the apparatus on the baseboard. Note particularly the holes that will have to be drilled to pass the wires along under the baseboard. In the picture wiring diagram of Fig. 3 the solid wires are above the baseboard and the dotted wires are beneath it. The wiring is so simple and there is so much space that you will have no difficulty in following the diagrams without any special instructions. Remember that you are dealing with very high voltages and take special care with every connection to make sure that it is firmly soldered so that it will not come loose and cause a short circuit.

THE leads on the transformer will be found long enough to reach directly to the points to which they are to be soldered except for the 7½-volt leads that connect to the filament terminals of sockets S2 and S3, the center tap of this same winding, which connects to one end of R2, and the center tap of the 2½-volt winding, which goes to the 45-volt binding post by way of the 9000-ohm tap on R1 and one terminal of condenser C8. These leads from the transformer are extended by means of the regular hook-up wire.

(Continued on page 84)

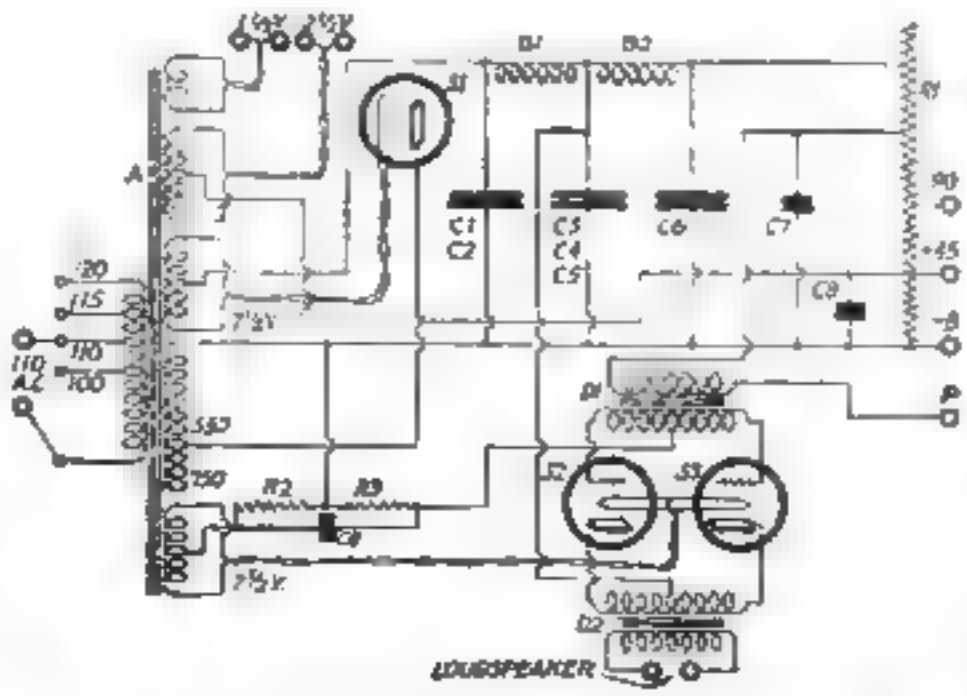


Fig. 1. This power amplifier and current supply unit can, of course, be used as a last stage amplifier and B-supply unit with any type of battery operated set

Before you buy a used car from a friend—

Send for THIS FREE BOOK!

Pledge to the Public on Used Car Sales

1 Every used car is conspicuously marked with its price in plain figures, and that price, just as the price of our new cars, is rigidly maintained.

2 All Studebaker automobiles which are sold as CERTIFIED CARS have been properly reconditioned, and carry a 30-day guarantee for replacement of defective parts and free service on adjustments.

3 Every purchaser of a used car may drive it for five days, and then, if not satisfied for any reason, turn it back and apply the money paid as a credit on the purchase of any other car in stock—new or used. (It is assumed that the car has not been damaged in the meantime.)

To the Public: We pledge adherence to the above policy in selling used cars.

Your Studebaker Dealer

IF you were about to buy a used car from a friend, would you know how to determine its fair market price? Do you know why some dealers mark their prices in code instead of plain figures? Do you know how to tell what year any used car was built?

You will find the answer to these questions and many others that any buyer of a used car should know in this free book, "How to Judge a Used Car." It tells you what to look for and what to avoid in purchasing a used car. It is based on the long experience of experts in buying used cars for Studebaker dealers—their sound, practical advice may be the means of saving you time and money. Send for it at once!

Studebaker is only too glad to help you get the greatest value in a used car for your investment. Because Studebaker dealers believe in this policy, they have adopted this famous Pledge. Wherever you see this Pledge displayed you can buy a Certified Studebaker with absolute assurance that it is worth what the dealer asks and will do what he says.

Mail this coupon for your copy of "How to Judge a Used Car"

The Studebaker Corporation of America
Department C56, South Bend, Indiana
Please send my copy of valuable free booklet, "How to Judge a Used Car."

Name _____

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STUDEBAKER

The Great Independent

Figuring from the minus-B end of R1, the 45-volt binding post is connected at 0000 ohms, the 90-volt binding post at 10,500, the wire from one terminal of condenser C7 at 21,000; and the wire from condensers C3, C4 and C5, which are in parallel, taps in at 32 000 ohms. The 41,000-volt tap is not used.

Before connecting the binding posts that are used for the light current supply to the primary taps of power transformer A, call up the office of the local power company and find out what the average voltage is in the lighting circuit in your neighborhood. Then connect the zero tap to one binding post and the next *higher* tap than the figure you get from the power company to the other binding post. If the voltage in your locality is somewhere in the neighborhood of 110 volts, for instance, use the 115-volt lead, and so on.

The block of filter condensers C1, C2 and so on are held in place by a heavy copper wire around over the top and another around them the other way near the base. This wire also serves as a common minus-B connection.

Be sure to ground the cases of all condensers and the frames of transformer A and the chokes B1 and B2. This means that you are to clamp a wire under one of the screws that holds transformer A to the baseboard and solder the other end of it to the minus-B wire at any point. Do the same for the two chokes. You will find that the holding wire can be tightened up enough to ground the cases of the condensers if you scrape a bright spot at the points where they touch each other.

Fig. 2. The [illegible] above. Note spacing of instruments to eliminate magnetic interaction

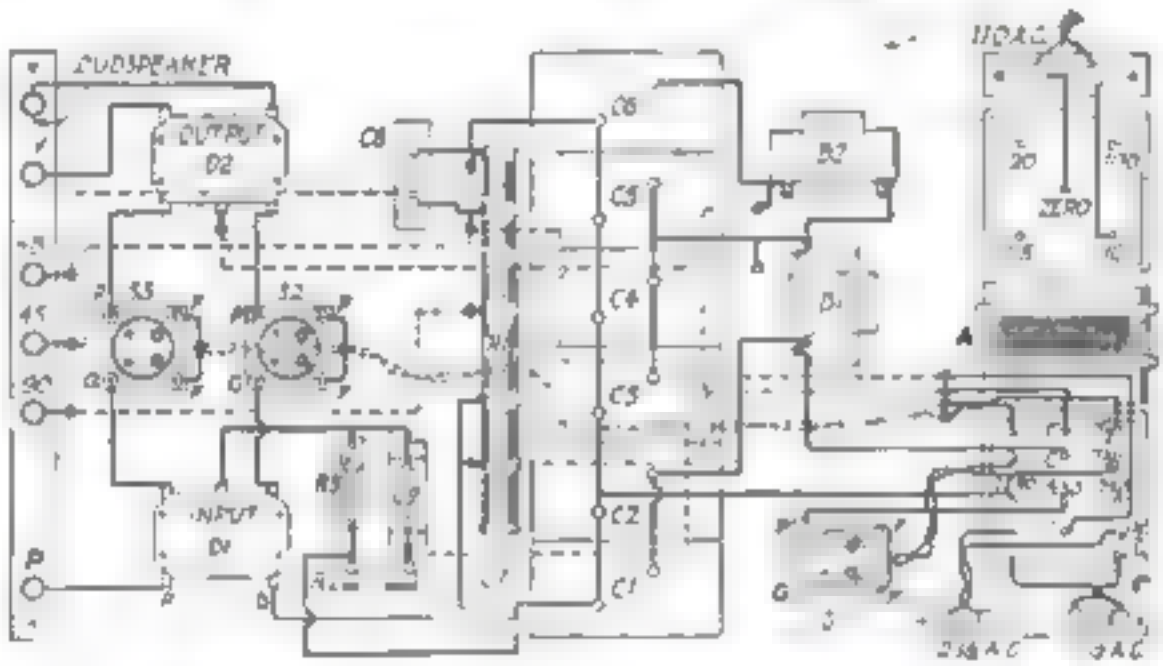

Fig. 3. Follow this picture diagram in wiring. The heavy black lines indicate wires above the baseboard; dotted lines, wires below. The ends of power transformer A have been turned so that connections are clear

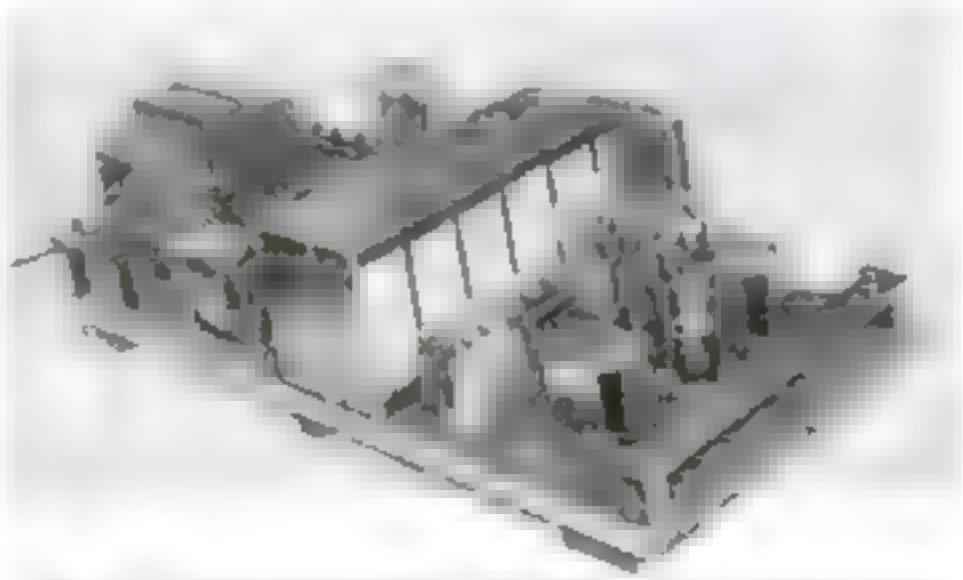

Fig. 4. Three crosspieces raise the baseboard and allow room for wires underneath. Drill holes for the wires before you screw on the crosspieces

TAKE especial care to see that the 1½- and 2½-volt leads from transformer A are solidly connected to the binding posts. A poor connection at this point will seriously interfere with the operation of the outfit. Carefully tape the 750-volt lead and the unused primary leads and push them down out of the way.

After you have finished wiring the unit and have rechecked your work several times to make sure that there are no errors, take a keyhole saw and cut out a large enough piece of the back of the lower compartment of the console cabinet to allow you to place the power unit inside. Leave the back of the cabinet open. These power tubes get quite hot and the opening will allow air to circulate around them to keep them cool. If the tubes are operated in a closed compartment, the excess heat will shorten their life.

Assuming that the radio receiver described last month is in the upper compartment, drill holes in the floor of the upper compartment so that you can pull through the leads from the receiver and connect them to the similarly marked binding posts on the power unit in the lower compartment. Leave the leads long enough so that you can pull the receiver out of the cabinet far enough to take the covers off the shield boxes.

Now insert UX-226 tubes in sockets G1, G2, G3 and G5 of the receiver and put a UX227 tube in socket G4. Then put a UX281 tube in socket S1 of the power unit and insert UX210 tubes in sockets S2 and S3 of the power amplifier.

Connect the antenna and ground and the loudspeaker to the binding posts provided on the set, and then plug the cord from the power unit into the nearest electric light socket. The UX 281 tube should light to a dull red and the 210 tubes should glow quite brightly. The 226 tubes light about like the 281 and after thirty seconds or so the 227 tube will also glow.

IF EVERYTHING has been done exactly according to instructions, you will hear a noticeable hum when you first turn on the current. This hum will continue till the 227 heats up, then it will die out to a very low figure, so low that you will not notice it at all unless you listen for it in a quiet room.

If all the tubes do not light as described, shut off the current at once and do not turn it on again until you have definitely located the trouble. *Caution: Never touch any part of the power amplifier and current supply unit while the current is turned on. Never attempt to operate the outfit unless the specified tubes are in all sockets.* If, for instance, one of the 210 power amplifier tubes in sockets S2 or S3 should burn out, turn off the current at once. The receiver would operate with only one 210 tube, but the tube would be severely overloaded, the plate of the tube would get red-hot and be destroyed in a very short time.

All operating voltages are fixed. There is nothing to adjust in the power amplifier and current supply unit. The values of the various resistances are such that the radio-frequency amplifier tubes operate at 95 volts with a C-bias of 0 volts and they draw close to 3 mils each. The detector tube gets 45 volts B current, and the first audio amplifier tube has 175 volts applied to its plate with a 12-volt C-bias. It draws 5½ mils. The 210 power tubes operate on 450 volts B with a C-bias of 35 volts and they draw 40 milliamperes.

The only adjustments you have to make are in balancing condensers C4 and C5 in the receiver, and you have to turn potentiometer R5 to the point where the hum is lowest. This latter adjustment has to be made in a quiet room with the loudspeaker fairly near your ear.

You must make yourself a special screw driver to adjust condensers C4 and C5 in the set. This should consist of a piece of wood slotted at one end with a washer or other thin piece of metal forced into the slot and (Continued on page 116)

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How to Care for Your Tools

Hints on Sharpening Chisels, Planes, Gouges, Scrapers, Auger Bits and Saws

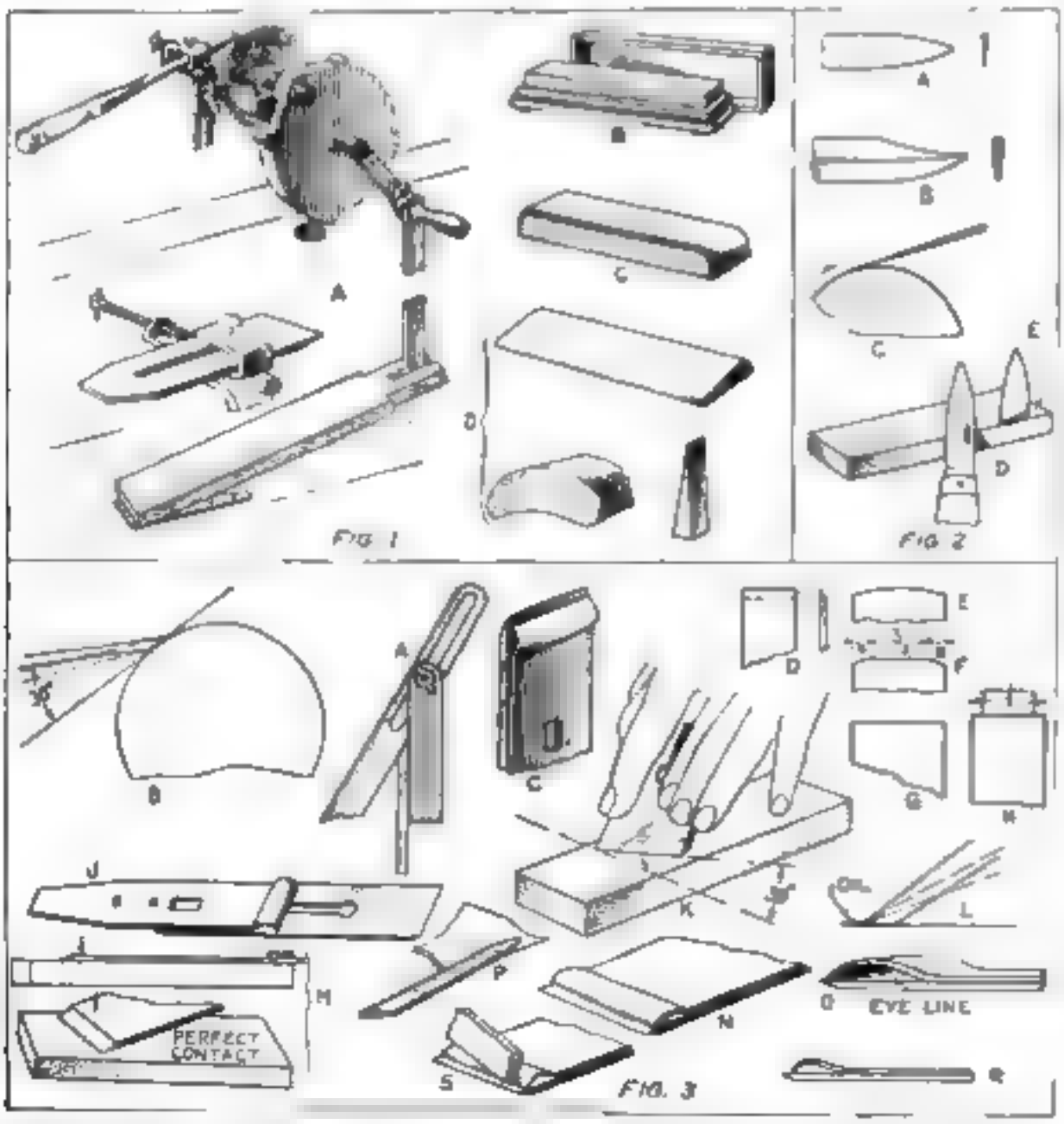
By CHARLES A. KING

To enjoy fully your home workshop you must have good tools and keep them well sharpened

HOME workers and manual training pupils often seem to think that time spent in sharpening tools is largely wasted. They prefer to "put to more strength," in the words of the Biblical philosopher who wrote: "If the iron be blunt, and he do not whet the edge, then must he be put to more strength but wisdom is profitable to direct" (Eccles. 10.10). Even apprentices are well advanced in learning their trades before they attain wisdom in the realization that time spent in sharpening tools will be more than repaid in the quantity and quality of their work.

Our discussion will be centered around woodworking tools, for they are more commonly used in the home workshop than others. A bench grinder (*A*, Fig. 1) with a 6 by 1 in. wheel will give satisfactory results in sharpening all woodworking tools and for general grinding. It can be converted to a foot power grinder by adding a treadle, which allows both hands to grasp the tool. A combination oilstone or whetstone *B*, 1 by 2 by 6 in., coarse on one side and fine on the other, which is set in an iron or wooden box to prevent the cutting surface from becoming glazed with dust, is an excellent general purpose stone. A strop *C* made of a piece of leather glued or tacked on wood, will make a keen edge a little keener. Slip stones similar to those shown at *D* are necessary if gouges or carving tools are to be sharpened.

From the time our primeval ancestor discovered that a broken bone or a clamshell could be worn to a cutting edge on a flat stone, the knife has been the universal tool. For general use the knife may be sharpened as at *A*, Fig. 2, but a knife for whittling should be similar to *B*. Lay the knife upon the grindstone tangent at the edge as at *C* and turn the stone toward the edge. Move the knife forward occasionally to maintain a nearly straight surface from the edge to the back. Reverse hands and grind the other side. Keep the knife moving back and forth the entire length of the edge to prevent heating. When a wire edge or minute burr turns over, the edge is finished.



For keeping your tools in condition you need a bench grinder, a whetstone, a strop, and one or more slip stones, as in Fig. 1. Methods of sharpening knives and planes are illustrated in Figs. 2 and 3

LAY the knife on the whetstone as at *D*, pressing lightly upon the cutting edge so the back edge will clear the stone a very little as at *F*. Remove the wire edge by drawing the knife across a piece of wood and give a few more strokes upon the whetstone, finishing upon the strop, if desired.

Workmen seldom think of the bevel of a cutting tool in degrees; they are guided by the eye and the "feel" of the tool. A rather thin edge is preferred in working soft wood, while a somewhat thicker edge will stand up better on hardwood and for general purposes. A thin edge is better for a paring chisel, and a thicker edge for a mortising chisel.

In deference to definition we must mention an angle, most cutting tools are ground to a 25- or 30-degree angle. Set a bevel at 30 degrees and test the bevel of a plane cutter or chisel as at *A*, Fig. 3. It is important that the bevel be true the entire width and thickness of the iron, though the periphery of the wheel will make the bevel a little hollow as at *B*.

The bench grinder may have a tool rest that can be moved from right to left, in which the tool may be clamped as shown in Fig. 1; thus insures accuracy. Usually the professional mechanic prefers a stationary rest and guides the tool by holding his fingers in one position against the rest. When grinding a plane cutter, set the cap iron back from the cutting edge about 1/16 in. as at *C*, Fig. 3, and use it as a guide for squareness instead of testing (Continued on page 126)

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Tricks of the Toolmaker

How to Lay Out Work Quickly and Accurately on Lathe and Milling Machine —Jigs, Fixtures, Piercing Punches and Dies

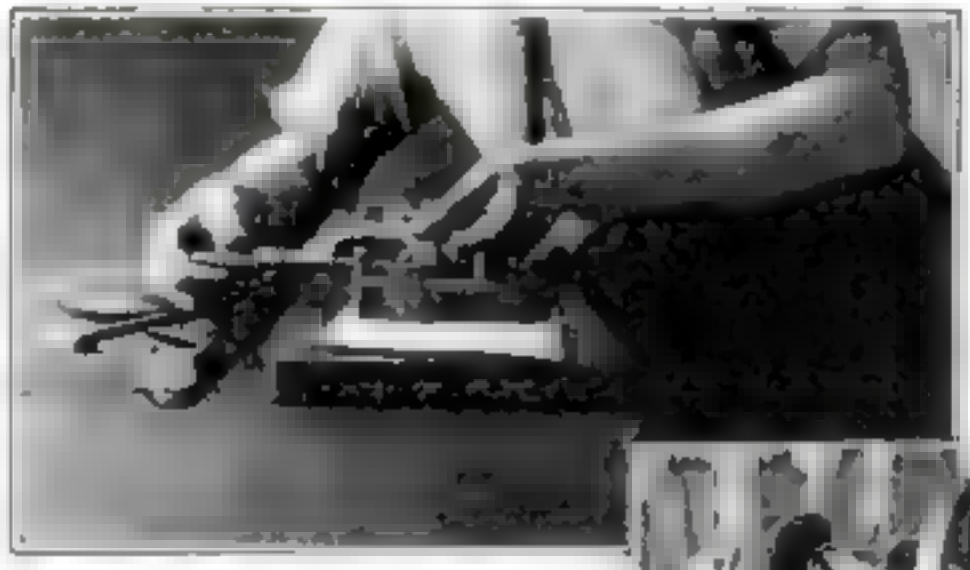
By HECTOR J. CHAMBERLAND

NEW stunts in laying out machine shop work, although they may appear to save time, are often lacking in either accuracy or practicability.

Anyone familiar with this line of work will admit that the method of using movable buttons is hard to beat so far as the average shop is concerned. Manufacturing plants engaged extensively in making jigs and the like are always on the lookout for production equipment and use jig boring machines, on which the spacing is done by the vernier system so that even [illegible] errors are practically eliminated. The ordinary shop, however, has to be content with the movable buttons and a good lathe and a milling machine.

A practical and accurate method to lay out work is to finish the piece to standard dimensions, grinding it if necessary, and use short parallels clamped or screwed to the sides, as in Fig. 1. This method is excellent in such work as matching piercing punches and dies.

An example is shown in Fig. 4, page 106. It is a piercing punch and die for hack saw backs. The boring is done in machine



clamps to hold the parallels for measuring. Small holes are drilled and tapped at convenient places. The parallels may be of any length, if accurate.

A good lathe may be depended upon to execute accurate work. Before boring in the lathe, one must exercise care in strapping the work to the faceplate and have it well balanced. Should the work shift slightly, the deviation might be in any direction, whereas if the boring is done on the milling machine, the work has very little chance of changing position.

Figure 4 gives an idea of an operation well fitted for the milling machine. The holes are located, drilled and bored [illegible] in. smaller than their finished size and tested with the parallels and a plug gage. Corrections, if necessary, are made with the aid of the dial indicator.

In this case the work is accurately squared and strapped to the table. The vertical fixture also should be set with the indicator, using a ½-in. cylindrically ground piece.

Provided the equipment is in good condition as a whole, no trouble should be experienced in spacing, and the boring can be done without any previous layout. A start is made on side *A*. The back lash is eliminated at all times and a piece of .001 in. thick paper is used between the side and the plug gage in the chuck. The .625-in. spacing of the No. 1 hole is first taken and the work continued towards side *C*, repeating the operation as before. After the holes have been bored to [illegible] in. and checked with a plug gage and parallels, the micrometer will show the accuracy of the machine.

If the location is off in either of the four directions, the (Continued on page 108)

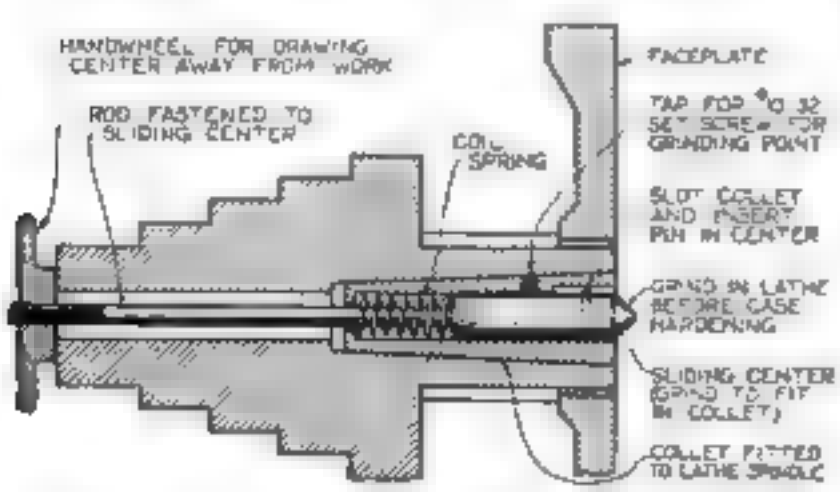


Fig. 3. A spring-actuated center for a lathe, which saves time in locating work that is to be clamped to the faceplate for boring

OTHER timesaving shop ideas are contained in the continuation of the BetterShopMethodsDepartment, which you will find on pages 98, 108 and 110.

Short Cuts *for* Machinists

A Simple Way to Use Gears for Indexing Work on the Grinder—Depth Gage for Lathe Drilling—Extension Tool Holder for Planer—Universal Joint for Floating Reamer—Other Shop Kinks

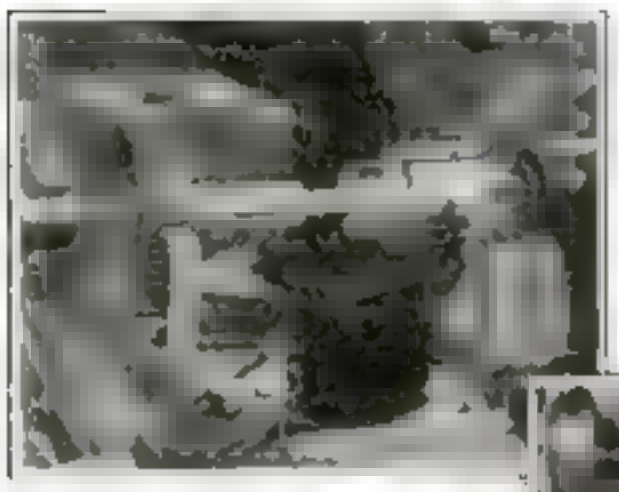


Fig. 1. A gear used on a grinder to index milling machine cutter heads

IT IS often necessary to grind indexed work, but as a rule no adequate or universal indexing fixtures are available for grinder work. It is not advisable to use a milling machine index head on a grinder as the work is likely to be ruined sooner or later for accurate work on the miller. It is also much too heavy for convenience

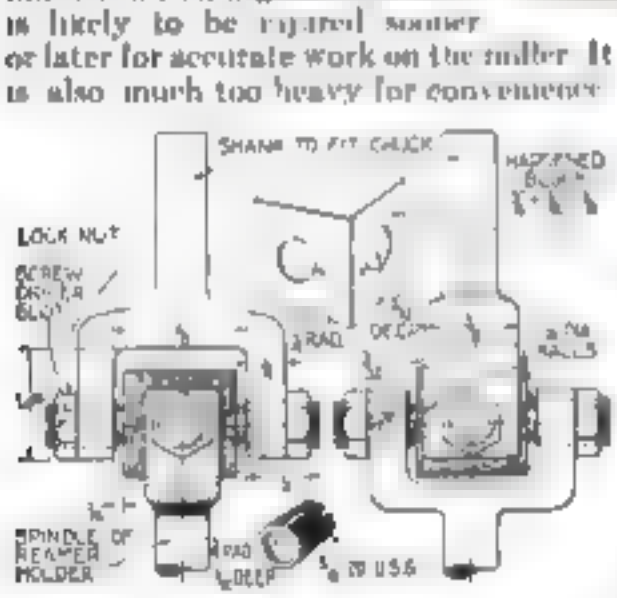


Fig. 6. A universal joint for a floating reamer. It is made of machinery steel, pack hardened

The simplest accurate method for universal indexing is to make use of change gears such as are supplied with universal indexers and with engine lathes. With these practically any required division can be obtained. Figure 1 shows a case in hand. Several cutter heads for milling purposes were ground by using a gear for indexing and a spring finger to lock it in position. O. S. Marshall.

WHEN drilling a job chucked in the lathe, such as, for instance, the one shown in Fig. 2, it is possible to rig a gage to indicate how far the drill has penetrated. A strip of sheet metal is secured to the drill chuck with a rubber band, and the end of the strip is lined up with the end of the drill and bent so that it just clears the work. The required depth of hole can be marked either on the gage strip or on the job itself. The idea might be carried further by using, instead of the sheet metal strip, a narrow steel rule, perhaps with a spring clip to hold it on the chuck.

When the job is of such shape that the gage strip will not pass over it while running, the strip can be bent down until it touches the drill, and set so that the end is exactly the depth of the hole from the point of the drill.

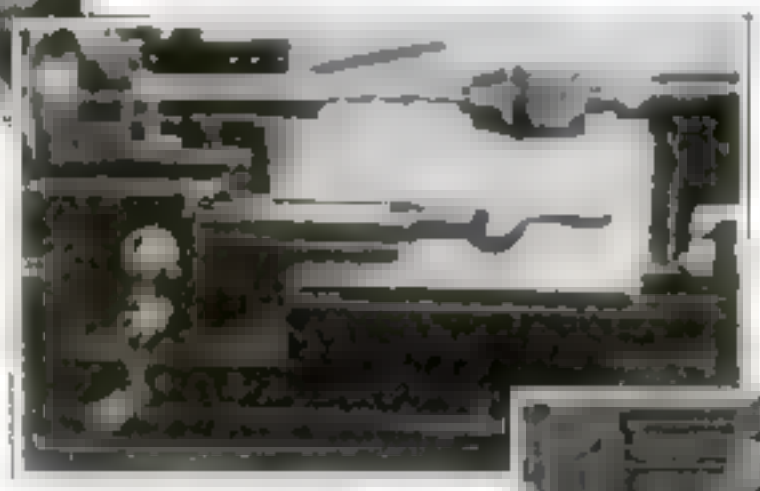


Fig. 2. A strip of sheet metal and a rubber band form this drilling gage

In practice this plan has been found quicker and simpler than putting a clamp, a tube, or a clip on the drill. Howard Cheney.

HOW to overcome the handicap of an old style planer with only a narrow opening between the housings is illustrated in Figs. 3 and 4. A tool holder was made as shown so that the full stroke of the planer does not have to be used. The inside of the tool holder was cut out with a torch to give ample room for bolting it in place. V. Skinner.

Fig. 3. Extension tool holder for planing wide work

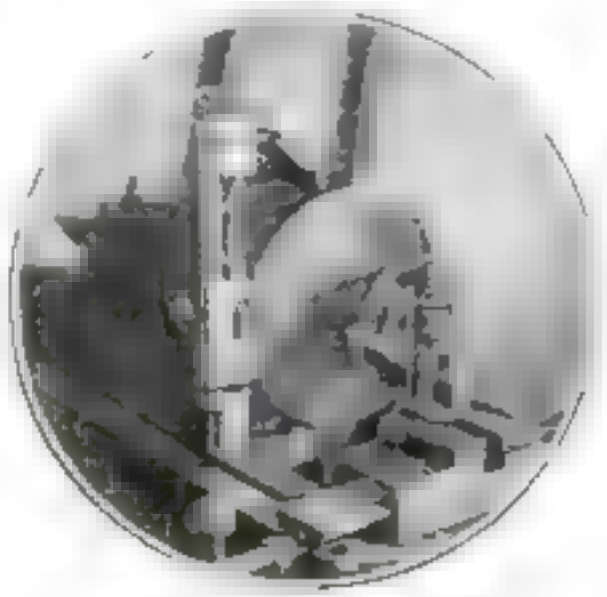


Fig. 7. A lathe indexing fixture for drilling, cutting teeth and graduating work accurately

Fig. 5. A cutting block for sheet metal with a spring grip to hold down the thin stock

FIGURE 5 shows how a bench block was fitted with a spring grip arrangement to hold thin metal down at one end while it is being cut off with a chisel. Spring wire was bent as shown, the ends were sprung into a hole passing through the block near the top and suitable coil springs were attached.—H. M.

THE universal joint so widely used in machine construction is also practical for floating reamers. In Fig. 6 is illustrated a joint that is easily adjusted to take up wear. —H. J. C.

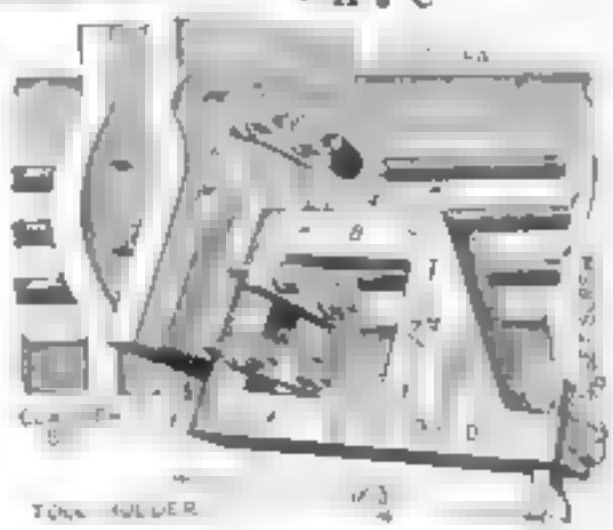


Fig. 4. How the extension tool holder is made. The large opening is cut with a torch

IN FIG. 7 is shown an indexing fixture for an engine lathe. A cast-iron or steel disk 10 or 12 in. in diameter is cut as a worm wheel on its periphery, preferably with 360 teeth. This is attached to the lathe spindle in place of the regular faceplate. A right-angle member *AD*, which is bolted to the bed of the lathe close to the headstock, supports a screw or worm, and at the upper end is an index plate *B*, and a crank and "flipper" pin *C*. This index plate, in conjunction with the large worm-wheel plate, provides for almost unlimited indexing operations. —O. M.

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How to Lay Out Your Shop for *Decorative* Metal Work

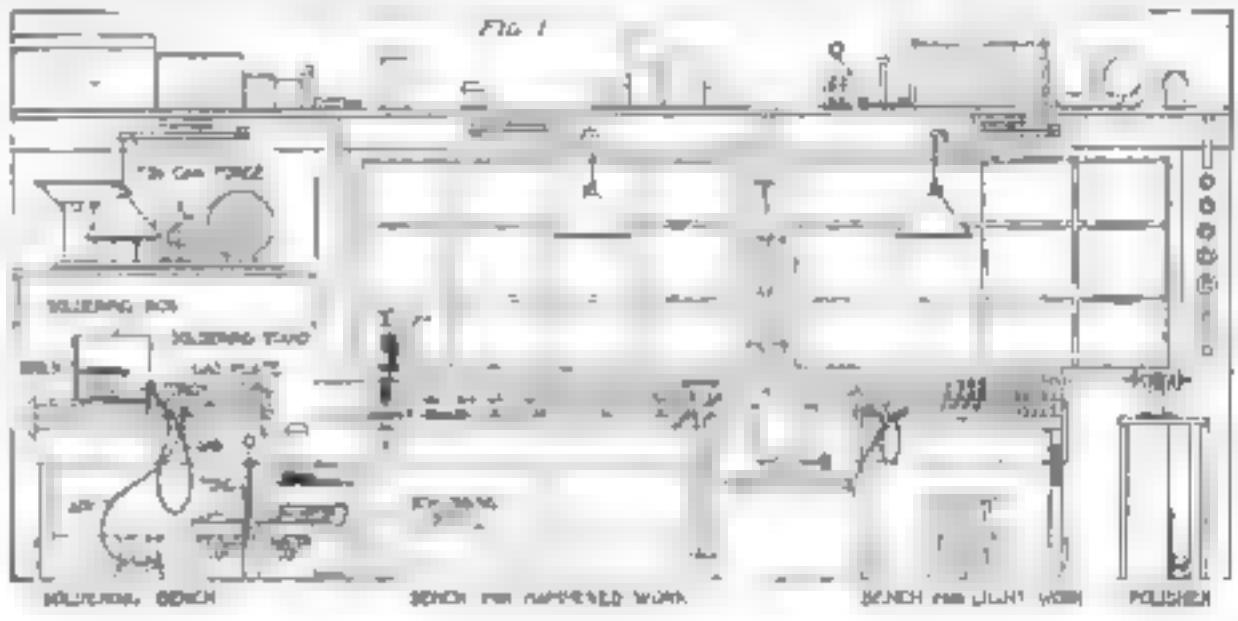
By EDWARD THATCHER

THE individual craftsman who takes up decorative metal work will, of course, adapt his shop layout to the space available, be it large or small. He may use benches and other equipment already in his possession provided they are in a good light. If there is only one window facing north, the best place should be given to the jeweler's or light work bench where one works seated.

The pickle and water crocks rest on the floor. A small gas plate is available for heating pickle, drying out work for hard soldering, and even for certain soldering operations.

The arrangement of this bench would be practically the same if a gasoline blowtorch were used.

A friend of mine built an old kitchen



An ideal layout for a home workshop to be devoted to craftwork in metal. The units may be rearranged to suit the floor space, but in any case the small bench should be under a window

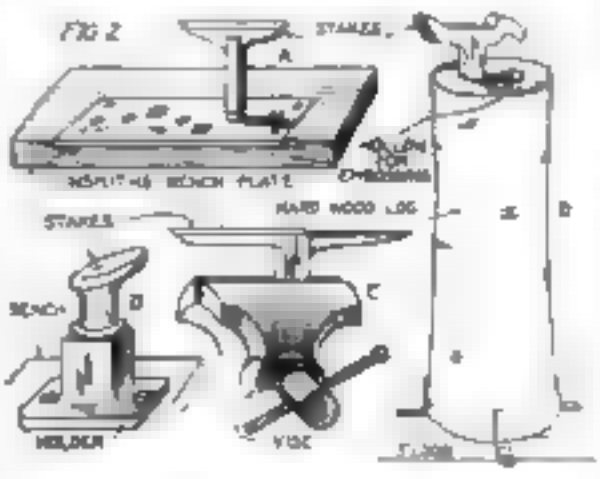
stove for a soldering bench, the large flat iron top making an excellent place for soldering operations. The top of a sheet steel oil stove could be used in the same way after the stove had outlived its usefulness in the kitchen.

A layout such as the one shown in Fig. 1, where the benches are all along one wall, makes for convenience when transferring the work from one bench to another.

Plenty of closet and shelf room is needed. A small case filled with sliding drawers, such as the one shown above the bench for light work, is convenient for storing rivets, screws, drills and the like. Supplies such as lump or powdered pumice, charcoal, pitch, resin and chemicals are best kept in labeled boxes. It is also a good plan to make a rack of some sort for sheet copper and brass. The high, narrow boxes used for glass by glaziers form excellent racks for flat sheet copper.

On the extreme left of Fig. 1 will be noted the soldering bench, the top covered with a layer of brick. On this bench stands the soldering box in which rests the soldering stand or turntable.

Near by is the blowtorch held by a special hook fastened to the bench. From the blowtorch runs a rubber hose to the foot bellows for the air supply, the other hose goes to a cock on the gas line. A pair of tongs hangs on a nail near the



Four ways to hold stakes for hammered work. That shown at B is the least noisy

ON A shelf above the soldering bench is a forge for light work. It is set down on the bench for supplementing the heat of the blowtorch when soldering or annealing large work or melting metal.

The bench for hammered work should be constructed very solidly. Although suitable dimensions were suggested in another illustration of the bench published in the first article of this series (November, 1927, issue), the width and length should be made to suit the space available. The height of the top of the bench from the floor should be so planned that when a stake is in the vise you may do hammered work in a natural position.

Generally, the top of the vise jaws should be on a level with the elbow or slightly below it. A bench top from 28 to 30 in. from the floor will usually give this height, depending on the

(Continued on page 122)

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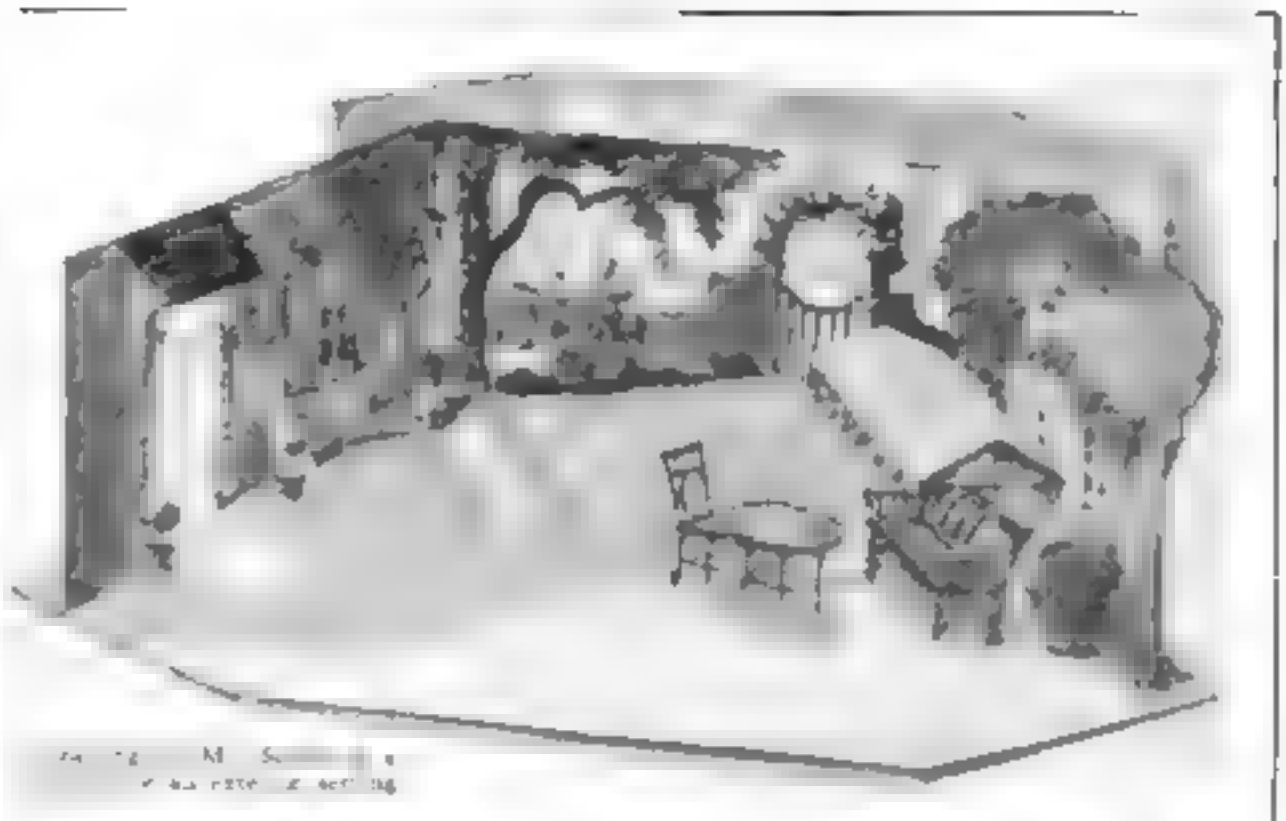


SCENECRAFT—The Exterior Set

How to Interpret the Playwright's Script—Sketches and Models—Hints on Painting and Lighting

By ANDRE SMITH
Author of "The Scenewright"

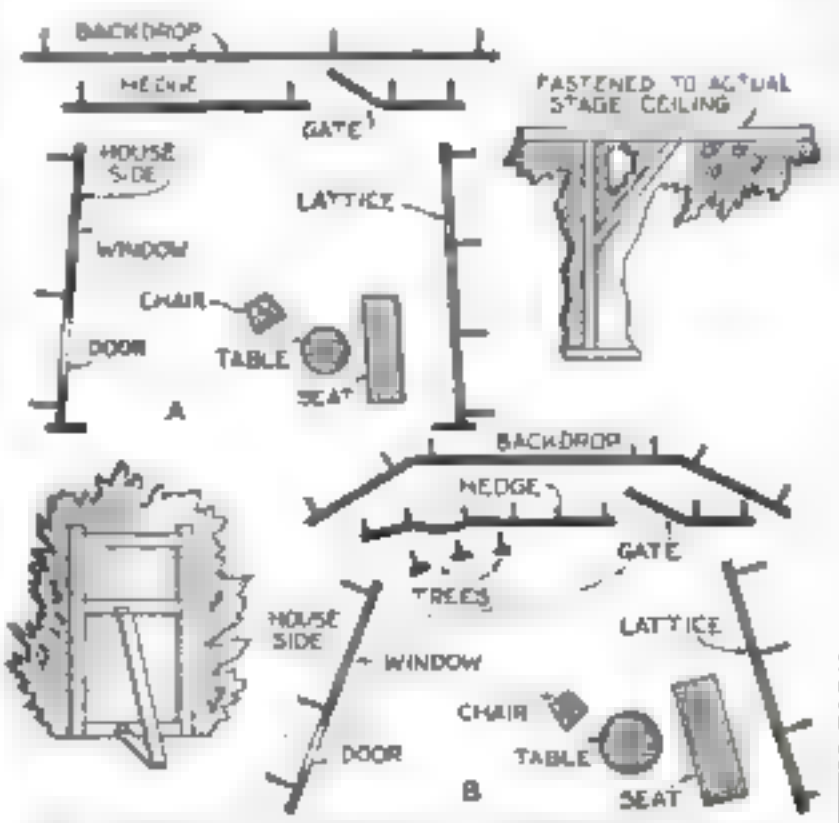
IN THE designing and building of an exterior setting the amateur scenewright finds himself up against a more difficult problem than any he has encountered in his experience with interiors. He knows well enough that he can create three walls of a room, but he stands in awe of the wall-less outside, where tree forms, flowers and atmosphere are perhaps the only limits to his set.

The problem, after all, is not so difficult as it seems. In the interior set the scenewright shuts off his back and side stage areas with three obvious walls, and in the exterior set he does the same, with this difference: the walls are *not obvious*.

In its crudest conception an exterior set consists of a back wall in the form of a painted back drop, and side walls in the shape of painted flats. As far as the exterior set is concerned it still remains, in spite of the healthy changes in the modern method of scene building, a matter of paint and illusion. Amateur play producers who have organized merely with the idea of giving one play, and who have to build their settings with as little fuss and expense as possible, can have no great curtain of blue canvas (cyclorama) to encircle the stage. Whatever bit of heavenly blue enters their setting will have to be done in paint on a back drop, and the actual stage ceiling or a painted blue lid will have to take the place of the infinite spaces of the sky. It is too bad, but it can't be helped. And so, facing our enforced limitations, let us tackle our problem with a stout heart and do the best we can.

In order to see how the thing is done let us set for ourselves an actual problem in scene designing. Let us suppose that the playwright's script reads as follows:

ACT TWO: The garden in the Bradley home. It is one of those simple New England back yard gardens, the kind that seems to be self-created, in which flowers happen as if by chance rather than by some skillful gardener's direction. The wall of the Bradley house occupies the right of the stage. It is a rear wing of the house and contains an entrance door and a window. Over the door is a simple shed roof supported (Continued on page 124)



The essential elements of the scene are indicated at *A* and an improved arrangement at *B*. Two tree forms are also shown

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Tools — Pride of My Farm

They Save Time and Money in Making Essential Repairs—My First Outfit and How I Added to It

By Garfield MacDonald

WE FARMERS are confronted with a difficult problem in selecting tools for our workshops. In the first place, most of us have not the time to spend in building things purely for pleasure; we build from necessity. In the second place, we are called upon to make many makeshift repairs on our implements and machines until parts come from the factory.

When I purchased my farm it was supposed to be fully equipped. Well it did have all the farming implements ready for action, but the tools consisted of a few rusty wrenches, a saw and a low grade hammer with one claw broken.

I purchased a few tools from time to time, being guided in large part by the lists of home workshop tools published in Popular Science Monthly some time ago. Now I have a complete set of tools which, besides being the means of saving me money, are my pride and joy.

My first outfit is ample for the beginner and serves as the nucleus for the second and third outfits, so that the farmer can add to it from time to time until he has a complete set of tools. It is as follows:

Spirit level, 24 in.	Pin punch
Hole saw, 2 in. threefold	Pipe wrench, 12 in.
[illegible]	Saw file, 6 in.
Flat chisel, 1 in.	Flat file, 8 in.
[illegible]	Lever tool
Iron jack plane	Shingling hatchet
Hand saw, 24 in., 8 points crosscut	Cold chisel, 1/2 in.
Chisels, 1/4, 1/2, 1 in.	Harness stitcher and repair outfit
Screw driver	Pliers, wire cutting
Try square combination, 12 in.	Oilstone

This set is inexpensive and in the hands of a man with a slight liking for repair work will serve for an astonishing variety of jobs. For the second set my choice comprises all the first set and the following tools:

Leather punch, 6 bits	Oil can
Screwdriver bit, handled adjustable wrench, 8 in.	Draw knife, 10 in.
Taper saw files, 1/2 doz., assorted	Screw driver bit
Flat files, 1/2 doz., assorted	Bits to complete set from 1/4 to 1 in. by 16ths
Half-round wood rasps, 3, assorted	Machinist's hammer, 1 1/4 lb.
Hand file for reaper blades	Block plane, lever adjustment
Breast drill, ratchet	Glass cutter
	Soldering outfit
	Steel square, 2 ft

Every farmer needs an assortment of good tools because of the variety of work he has to do in repairing implements and machines

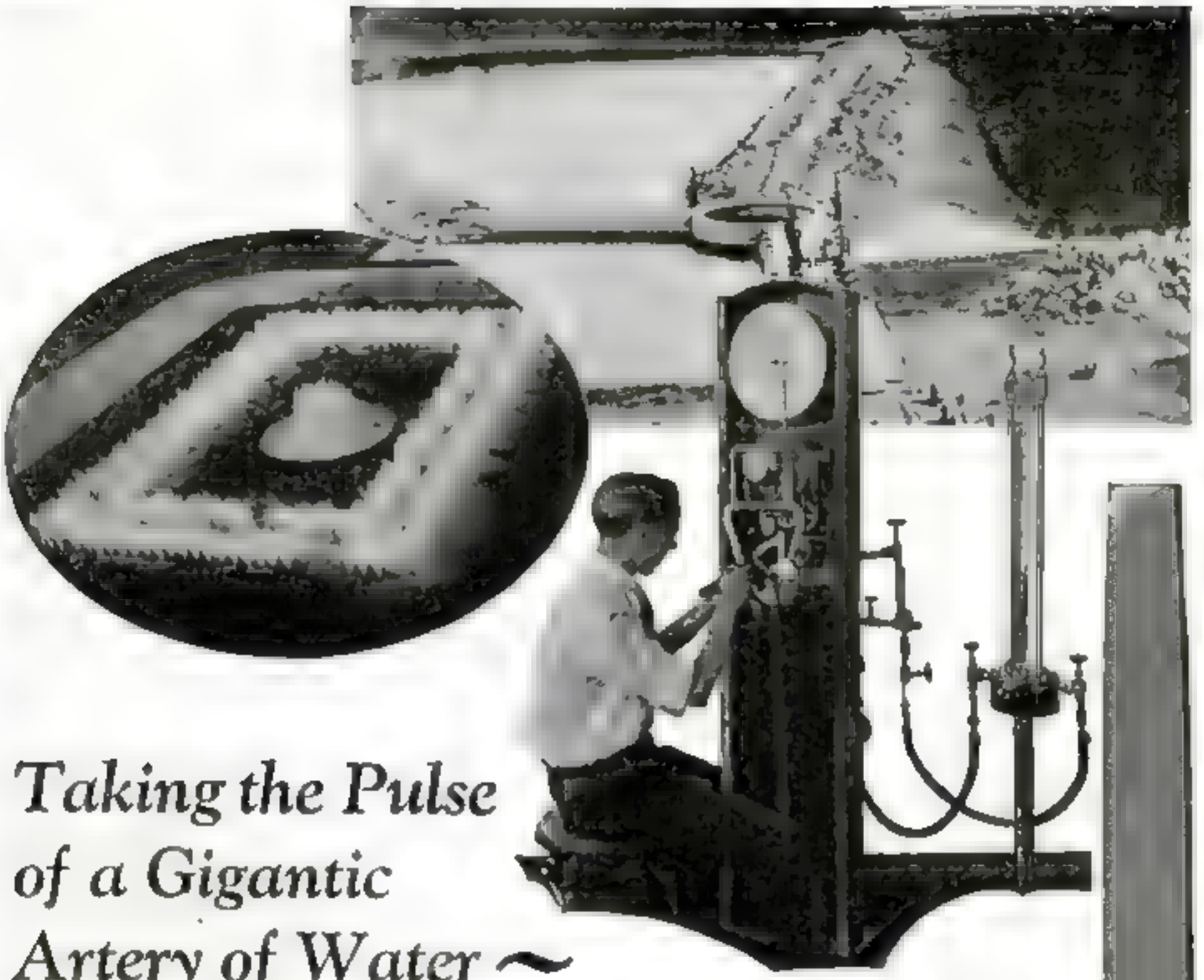
Round shank drills, [illegible] in.	T level
Sharp nose pliers	Jack hammer
Pistol grip bark saw	Vise bolt jaws
Hack saw blades, 12, assorted lengths	Compass saw, 12 in.
Tool grinder	Hand saw, 20 in., 8 or 9 points
Saw set	Rip saw, 26 in., 6 points

With this set a farmer can make difficult repairs on machinery, erect buildings, and do countless repair jobs. While this is a representative assortment, it is not supposed that the list will be adhered to strictly, it may be modified to suit any special needs.

The third set consists of tools of the first and second sets with the addition of the following. The forge enables a man to make even difficult metal repairs on machinery

Miter box	Farrier's hammer
Tape line, 100 ft.	Blacksmith's hammer, 2 1/2 lbs.
Hollow countersink	Bolt tongs
Smooth plane	Straight lip tongs
Hewing ax	Blacksmith's pincers, 12 in.
Carpenter's pincers	Farrier's knife
Engine cylinder oil	Mortise gage
Cold chisels, 1/2 doz., assorted	Spokeshave
Hand drill and set of bits	Floor scraper
Chisels, 3/4, 1 1/2, 2 in.	Tin snips
Hollow pattern planes	Chain hoist
Taper rod file set, 1/4 [illegible]	Socket wrench set
	Valve grinder and paste
Forge, 22-in. hearth	Hydrometer
Anvil, 75 lbs.	Five-minute vulcanizer
Horse rasps, 2	

I always have on hand in the shop a good stock of hard and soft wood, strap and bar iron, nuts, bolts and washers, glue, rivets, screws and nails, belt lacing and harness leather.



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— A FILE FOR EVERY PURPOSE

Wood Turning Simplified

Choosing a Lathe—Spindle Speeds—How to Sharpen Gouges and Chisels

By Herman Hjorth

Fig. 1. Thumb-nail test for a chisel; if it "takes hold," it is really sharp

Fig. 2. The edges of scraping tools are sometimes turned over with a burnisher to form a burr or hook

IF YOU have a hobby, you may consider yourself fortunate in this age of speed and mental strain. An interesting hobby takes the mind off business problems, gives it a rest, and tends to keep it healthy and normal. Modern psychologists, medical practitioners and educators stress the value and importance of developing a hobby; indeed, it is one of the frankly avowed aims of manual arts instruction in the schools of today.

An ever-increasing number of men find relaxation in their home workshops. If you are one of them, you can add greatly to your enjoyment and at the same time improve your craft work in quality and variety by learning how to do wood turning. And this is not hard to do, especially now that such excellent motor-driven lathes are available at reasonable prices.

There is an unescapable fascination about wood turning. The shapes seem to form by magic under one's gouge and chisel. Perhaps that is why kings and princes and even queens and ladies of high rank amused themselves by practicing wood turning during the seventeenth century. Examples of their handwork are to be found in many European museums.

Simple as wood turning is, the beginner will make much faster progress if he takes the pains to observe the suggestions which will be given in this and following articles.

As a result of many years of teaching experience, the author will explain something that is really a great deal easier than conventional wood turning. It is what might be called "wood scraping." This can be mastered more quickly and, generally speaking, is more accurate than orthodox wood turning. While it is not quite so fast, this is a matter of small importance from the standpoint of the amateur. Almost anyone can do scraping at once without the many discouraging and disheartening slips of the tool and consequent spoilage of work so characteristic of wood turning practice.

Those who have learned or taught wood turning in the generally accepted way may disapprove of this method. In its justification, however, it may be stated that pattern makers do all turned work on wooden patterns by means of scraping. If the method is effective in such accurate work, why is it not equally useful in producing turned parts for other purposes? Many manual training teachers will permit scraping in difficult places and on what is called faceplate work. Why not then be frank

(Continued on page 100)

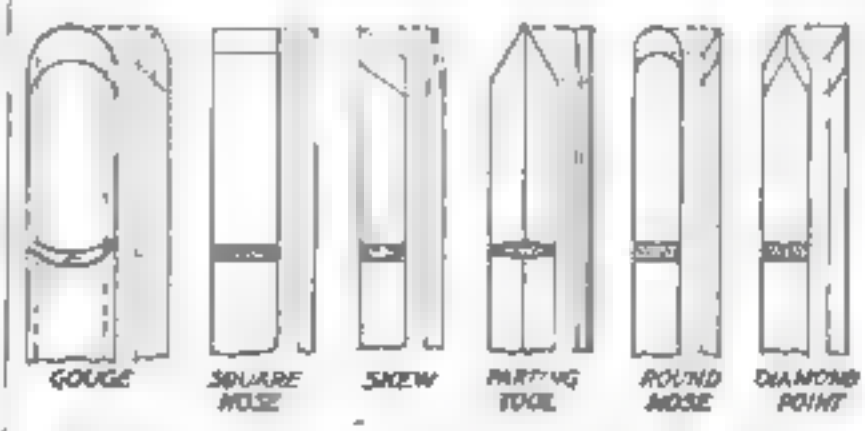


Fig. 3. A set of turning tools for the beginner. They must be supplemented by calipers, dividers, rule, oilstone and slip stone

Wood Turning Simplified

(Continued from page 165)

about it and teach a method that will give the most pleasure and profit to the learner?

It is with this need in view that the following instructions, which have been tried out in actual school work, are given. The procedure is the same whatever the size of the lathe and whether you are turning a candlestick on a small motorized home workshop outfit or a table leg on a larger lathe such as that shown in Fig. 5, below. Note well the names of the various parts, for they will be mentioned repeatedly in this and following articles.

Fig. 4. A skew chisel is ground angularly

Selecting a lathe depends, of course, on several factors, such as the type of work to be done, the space available and the price. The majority of the many small lathes now on the market suitable for home work are equipped with attachments for sawing, boring, grinding, buffing, sanding and the like. A surprising amount of work can be done on such an outfit.

For general woodworking and furniture making, it is well to select a lathe that is at least 30 in. long between centers—the standard length of a table leg—and has a swing of at least 9 in. The height of the lathe center over the bed indicates the swing; that is the diameter of the stock which can be turned. If it is 6 in. above the bed, the lathe has a 12-in. swing. Lathe beds of extra length can usually be obtained at a slight additional cost.

A motor-head lathe, that is, one with a variable speed motor mounted directly on the headstock, is the most convenient to use and takes up the least space. The more common type of lathe shown in Fig. 5 is driven by means of a cone pulley belted to a countershaft, which has a similar cone pulley and also a tight and loose pulley. The countershaft is generally fastened to the ceiling beams above the lathe. A small motor drives the countershaft and this in turn drives the lathe. By means of a belt-shifting device, generally consisting of an iron fork to which a wooden handle is fastened, the belt is moved from the loose to the tight pulley when it is desired

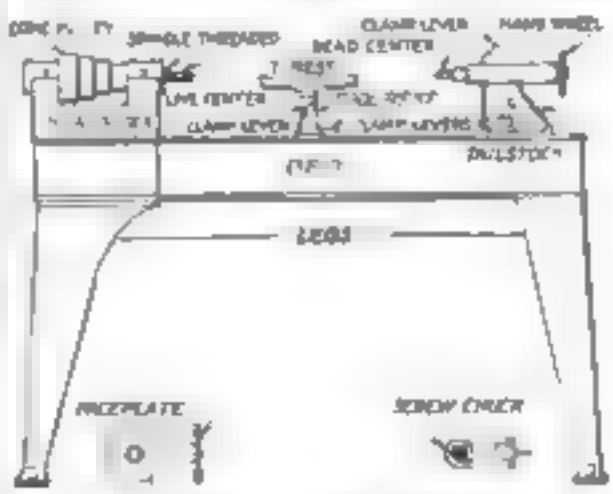


Fig. 5. A typical wood turning lathe. All lathes have substantially the same parts

to start the lathe. Sometimes a special motor is furnished with the lathe and is fastened to the legs below the headstock.

A lathe should run at a speed of about 2500 revolutions a minute when the belt is on the smallest step of the cone pulley. If it is necessary to buy new pulleys when installing a lathe, their diameters can be easily calculated if it is remembered that the diameter of the driven pulley times the number of revolutions it makes is always equal to the diameter of the driving pulley times the number of revolutions it makes.

Suppose we buy a lathe with its corresponding countershaft and the cone pulleys have three steps, the smallest being 3 in. in diameter and the largest 9 in. The tight and loose pulleys measure 6 in. in diameter. We have a ½-H. P. motor with a speed of 1200 revolutions a minute. The motor is equipped with a pulley 4 in. in diameter. Will this motor drive the lathe at the proper speed?

IT IS first necessary to find the speed at which the countershaft will revolve when it is belted to the motor.

The revolutions of the motor multiplied by the diameter of the pulley equal the revolutions of the countershaft multiplied by the diameter of the loose pulley.

1200 x 4 = rev. of countershaft x 6
4800 = 800 x 6
4800 = 4800

The countershaft makes 800 R. P. M., therefore the cone pulley on the countershaft also makes 800 R. P. M. The problem now is to find how many revolutions the lathe spindle makes.

The revolutions of the countershaft multiplied by the diameter of the large cone pulley equal the revolutions of the live spindle multiplied by the diameter of the small cone pulley.

800 x 9 = rev. of live spindle x 3
7200 = 2400 x 3
7200 = 7200

Stock not more than 3 in. in diameter can be turned at the highest speed of the lathe (2400 R. P. M.). Stock from 3 in. to 6 in. in diameter should be turned at a medium speed with the belt on the second step of the cone pulley, and stock over 6 in. in diameter should be turned at the slowest speed of the lathe.

Before the stock is rounded off and runs true in the lathe, it causes a good deal of vibration. The lathe should, therefore, be run at a lower speed until this process has been completed, as excessive vibration may cause the stock to be thrown violently from the lathe.

For the first lathe work, the following tools (see Fig. 8) are sufficient: 1-in. gouge, ½-in. square-nose chisel, ¾-in. skew chisel, ½-in. parting tool, ¾-in. round-nose chisel, ⅜-in. diamond-point chisel, 6-in. outside spring caliper, 6-in. inside spring caliper, 6-in. wing dividers, rule, oilstone and slip stone.

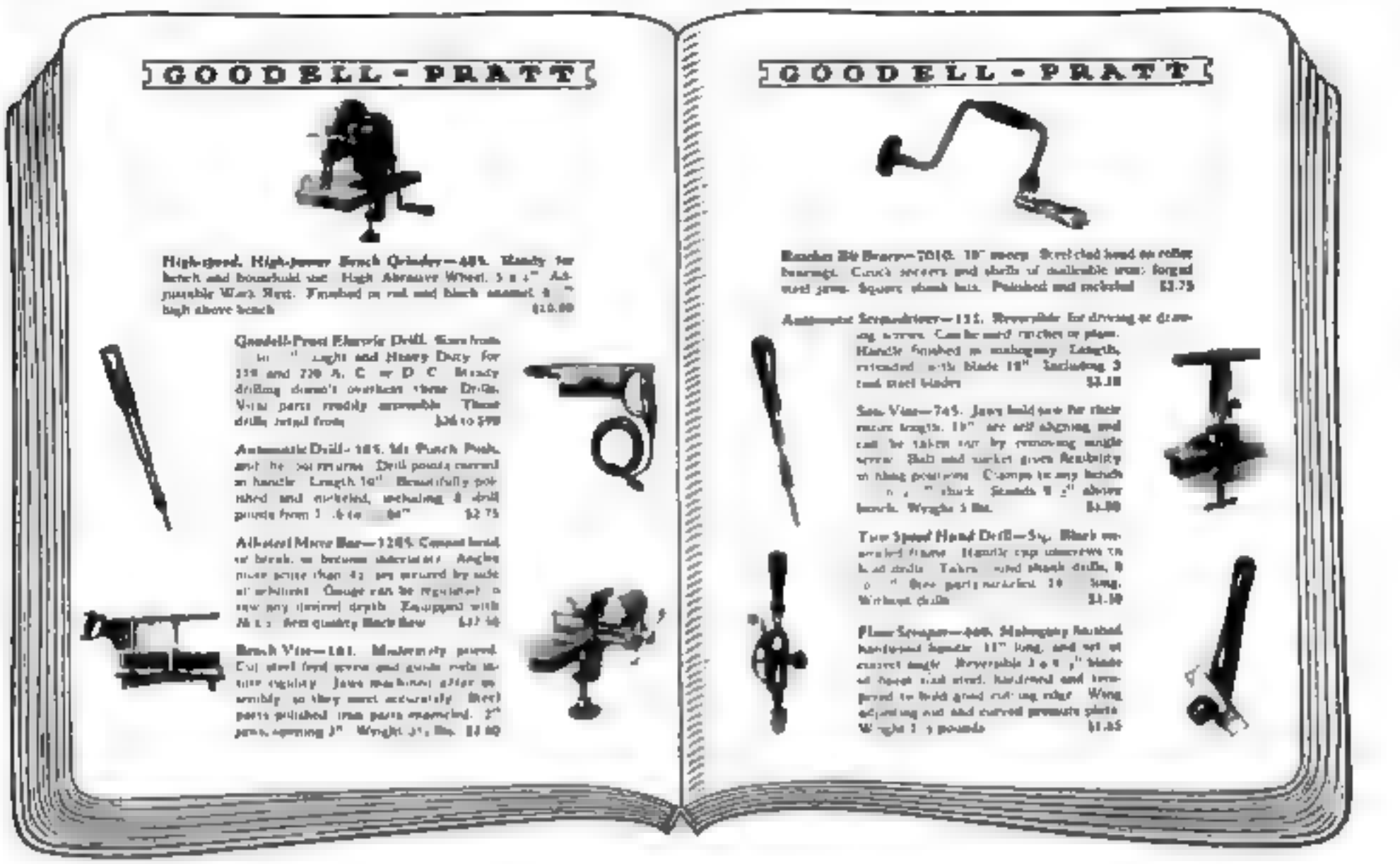
THE gouge is ground to semicircular shape with the bevel extending well around to the sides so as to leave no sharp corners as on the carpenter's gouge. The bevel should be about twice as long as the gouge is thick. It is ground on a wet stone or an emery wheel. If no water or kerosene runs over the stone, care should be taken to dip the tool frequently during the grinding process to prevent overheating and drawing the temper of the steel.

Grasp the handle with the right hand, hold the blade to the surface of the stone with the left hand and move the gouge across the face of the stone with a rolling motion.

When ground, the gouge is whetted on an oilstone. The bevel is brought in contact with the stone and the gouge moved back and forth and simultaneously rolled from one side to the other. The wire edge, which is bent towards the inside by this process, is removed by rubbing the rounded edge of a slip stone back and forth over it. Keep the whole edge of the slip stone in contact with the inside of the gouge during this operation.

While the square-nose turning chisel is longer than an ordinary chisel, any common chisel can be used in place of it if it has a long blade and is fairly

(Continued on page 214)



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THE SHIPSHAPE HOME

How to Fill Cracks Around Bathroom and Kitchen Fixtures and in Plaster Walls

By F. N. VANDERWALKER

EVEN the most carefully constructed house will suffer a little from the settlement of the foundation. Some cracks will open in the walls and the joints in floors, wood trim and built-in plumbing and cabinet fixtures. Furthermore, the shrinkage of lumber opens up cracks in wood trim and in floors, such as those often seen about a fireplace and hearth of tile or brick. With the flight of time other defects become noticeable

These defects may not be serious, but they constitute eyesores. No one likes to be confronted with a number of indications of wear and tear yet how to have them taken care of is a problem The jobs are too small for neighborhood tradesmen to be interested in, if they make such repairs at all, it is usually the result of repeated telephone calls and much bother

Almost all such minor repairs can be done just as well by any person about the house as by a skilled mechanic, once the right material and a little information are at hand Incidentally, there is considerable saving in both time and money to say nothing about convenience in doing the job yourself

In this and following articles the necessary information for filling holes and cracks will be set down tersely. Materials, tools and methods will be described.

Plaster of Paris, patching plaster, and white lead putty are used to fill bathroom cracks

Bathroom Cracks

RECESS tubs which are butted close to tile and plaster walls, sometimes pull away from the tile, leaving an unsightly crack. The settlement of the floor and the shrinkage of timbers in the wall are the usual causes.

To fill such cracks, the first step is to cut off all loose cement and sharp projections with a putty knife or screw driver. Be careful not to dig at the surface so hard that the vitreous coating on the tub or wall will be scratched or chipped.

If the crack extends down deeply between the tub and wall, any filling of putty will drop down out of sight. Consequently, this space must first be filled to within an inch or two of the top with strips or wads of newspaper.

There are a number of materials that can be used for filling such cracks. A dime's worth of plaster of Paris will do. Dump it into a clean can and cover completely with water. It will keep soft indefinitely as long as it is submerged. Take out a handful and knead it with your fingers until it becomes plastic like bread dough. Fill the crack with this putty, after first wetting the opening with water. Crowd the putty down well with a putty knife or spatula and smooth it off. Wipe off the surrounding surface with a damp cloth, and the job is done.

Such a filler, being porous, will accumulate dirt and become discolored To avoid this, coat the filling twice with white enamel or lacquer.

Another excellent filler is one of the prepared patching plasters, which come in dry form and can be bought at hardware and paint stores.

Putty mixed from white lead paste, dry whiting and a few drops of varnish or japan drier makes one of the toughest and best fillings for such cracks. Such a filling will take two or three days to get dry, but eventually it will become almost as hard as stone. It is not a porous filling that will catch dirt, but a coating of lacquer or enamel will make it still smoother and better.

Another type of filling is plastic paint, which comes in dry form. When wet with just enough warm water to make it stiff and plastic, it can be used as described for plaster of Paris.

Cracks and other openings about kitchen sinks and lavatories may be filled in the same way. The enamel or lacquer coating is necessary wherever water is likely to be splashed on the filling, except in the case of the white lead and whiting mixture.

Cracks in Plaster

THE defects found in plaster walls are settlement cracks at corners and elsewhere, fine cracks, door-knob bruises, abrasions made by furniture, toys and other objects, and nail and screw holes.

Very fine cracks are not large enough to be filled with putty, yet when painted they absorb the liquid and show up as flat streaks much wider than the cracks themselves. About the easiest way to conceal these fine cracks is to coat them with shellac or var- (*Continued on page 105*)

The Shipshape Home

(Continued from page 102)

nish and, when dry, to coat them again with flat paint of any kind before painting the entire wall or ceiling. It is also necessary to stop up these fine cracks thoroughly when wall paper, canvas or other fabric is to be applied. The cracks will absorb moisture from the paste and the covering will not stick to the dry paste.

When the cracks are large enough to allow a lead pencil point to be inserted scrape the surface lengthwise with a bit of broken window glass to cut off the lip that makes one side higher than the other, if there is a lip. Next, run a putty knife or other sharp tool through the crack to make it as straight as possible and cut off loose projections from both sides. Remove all loose chips and fill the crack well with water, using a small brush; if oil putty is to be used coat the crack with linseed oil, not water.

Probably the most convenient filling material is one of the prepared patching plasters. They set smooth and adhere to the surface without shrinkage. When dry, smooth up with No. 0 or No. 1/2 sand paper and coat with shellac before painting, calcimining or covering with wall paper or fabric. It is well, too, to coat the shellac with flat paint before painting the entire surface, if it is to be painted.

Other putties can be made by adding dry whiting to any flat wall paint or to white lead paste thinned with a few drops of linseed oil.

All of the materials used for putty set slowly and allow plenty of time for the work, except plaster of Paris. A wad of this will begin to set in about five minutes after removing it from the water. It should not be used in that condition. A little dry whiting or hydrated lime added to the plaster of Paris slows down its setting without injury to it, but do not use the vinegar or the glue size sometimes recommended for that purpose.

Sealing Fire Cracks

When a wall or ceiling is completely covered with a network of fine "fire" cracks too small to be filled, it is too much work to shellac and flat-paint them. Other means are quicker and better. One of them is to apply a size coat consisting of one half first-class floor varnish and one half turpentine. Mix in also a little white lead or flat wall paint and a handful or two of dry, fine pumice stone.

A second method is to size the wall with a mixture of one gallon of boiled linseed oil and one quart of turpentine. In bad cases it is well to fill the larger cracks of this type before the varnish size, or before or after the oil size, is applied. Thin some white lead-in-oil paste or flat wall paint a little with turpentine, run a stripe over each crack, let it set about five minutes, and rub well into the cracks with a rag.

This is the first of a series of articles by Mr. Vanderwalker, who is one of the leading authorities on painting and decorating.

Blueprints for Your Home Workshop

ANY ONE of the blueprints listed below can be obtained for 25 cents. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

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Tricks of the Toolmaker

(Continued from page 89)

correction should be made with the dial indicator. This method will prove safer than relying on the dial on the machine, especially if the error is in the opposite direction to the last setting.

If the ½-in. reading proved to be accurate, the operator has no reason to worry. Nevertheless, every hole should be checked undersize, which is much safer than the ordinary method of doing this before starting to bore by using the plug gage in the chuck.

For hole No. 2 time is saved by coming to side *D* and getting the hole accurate from the two sides. The 3.750-in. spacing will prove correct because of the accurate dimensions of the plate being bored. Moving back to side *D*, the .875 spacing is taken lengthwise. No. 4 hole is located and bored, then No. 3 hole from side *A*, and so forth until all the holes have been located and bored.

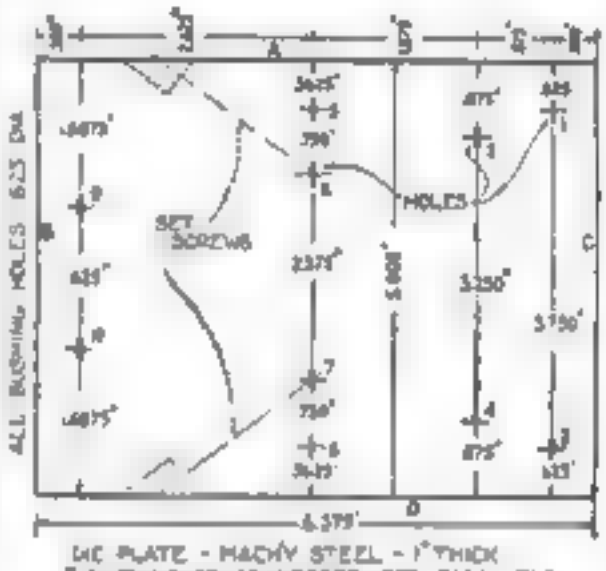

Fig. 4. Die plate for a piercing punch and die used in manufacturing hack saw backs

This may appear to be a very long job, but accuracy here is the main factor, as the stock punched out with the finished punch and die is bent perfectly central and the holes must line up.

The upper of the two drawings in Fig. 5 shows a job that can be laid out quickly and accurately by using four buttons at a time.

Figure 6 illustrates the method of making a plate to be used as a distance testing fixture. The plate itself is shown in the lower drawing of Fig. 5. It is made of die steel, laid out the usual way, hardened and ground all over to exact dimensions. The .375- and .500-in. holes must be accurate within .0001 in. The allowance for grinding, including the holes, is .010 in.

The piece is surfaced off and squared to size on the surface grinder. The faceplate of the universal grinder is ground square and the testing plate is clamped to it. The .500-in. hole is trued up with the indicator; it is then ground .0005 in. undersize. The plate is removed from the machine and the hole lapped a good fit on the .500-in. plug gage. The .375-in. hole is then plugged with a piece of soft steel. After the end of the plug has been squared, it is drilled and tapped for the movable button. The distance is now laid out (Continued on page 110)

Tricks of the Toolmaker

(Continued from page 109)

with the plug gage in the other hole. The plate is trued up again from the button and made secure on the faceplate. The plug, which should not be tight in the hole, is pushed out with a rod running through the spindle. The hole is then ground to .005 in. undersize and a test is made with a plug gage. If the distance is correct, the hole is finished to .0002 in. undersize and lapped. The small allowance for lapping this hole is reasonable on account of the exact limits in respect to the spacing.

In many cases the boring is done in the punch and die holders instead of steel plates. The first hole in each holder is laid out to match and the others are

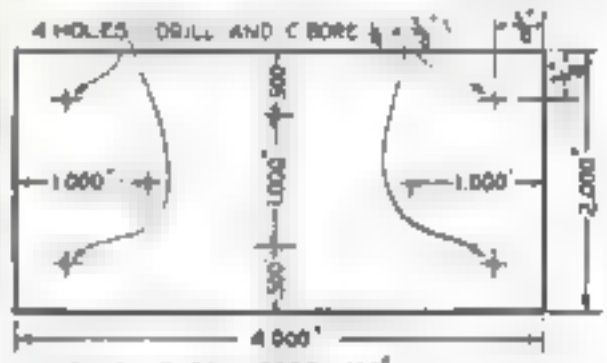

Fig. 8. A jig plate that can be laid out by using four buttons at a time, and a testing fixture, which is shown set up in Fig. 9

spaced and bored from these individually. The post holes in the punch holder are generally bored much larger than the posts. After the punch and die are fitted to each other, the holes in the punch holder are babbitted, thereby insuring a perfect line-up of the entire job.

It often occurs that many flat pieces have to be bored in the lathe, sometimes two or three holes in the same piece, not necessarily exact work. These jobs are costly on account of the time spent getting the locations. By drilling these clear through and counterboring one side with a medium-size center drill, and making a quick-locating center as in Fig. 8, much time can be saved. The tool will prove handy and will soon pay the initial cost. It is made of machinery steel, only the point of the center being case-hardened.

A collet is made to fit the lathe spindle accurately. A sliding center acting on a coil spring fits the bore in the collet. One end of the rod passing through the spindle is fastened to the back end of the center; the other end is threaded for a small handwheel. Guided by the center hole, the piece to be drilled is brought against the center and pressed to the faceplate. Clamps, which have previously been set handy, are tightened. The center is now drawn away enough to clear the work and the job is ready for boring.

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Cracked water jackets

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Doing your own repairing with Smooth-On No. 1 enables you to keep the repair money in your own pocket, to demonstrate to your wife, your ability as a handy man, to avoid delays and annoyance while waiting for outside repairmen, and gives you the satisfaction of being self-dependent. Once familiar with what Smooth-On No. 1 can do, you will smile at many jobs that you formerly wished you could dodge.

Smooth-On No. 1 is sold in 7 oz., 1 lb. and 5 lb. cans. If you can't get the size you want from your dealer, write us direct

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Please send the free Smooth-On Repair Book.

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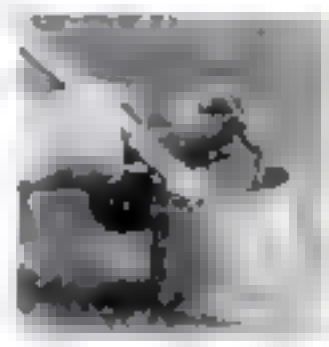
This seal on a radio, tool or oil burner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

SURFACES to be painted, whether wood, metal or composition, must be dry and clean. Any knots and sappy spots in woodwork must be covered with shellac. Cracks and depressions are first painted with linseed oil and then are smoothed over with putty. Iron must be free of rust before it is painted.

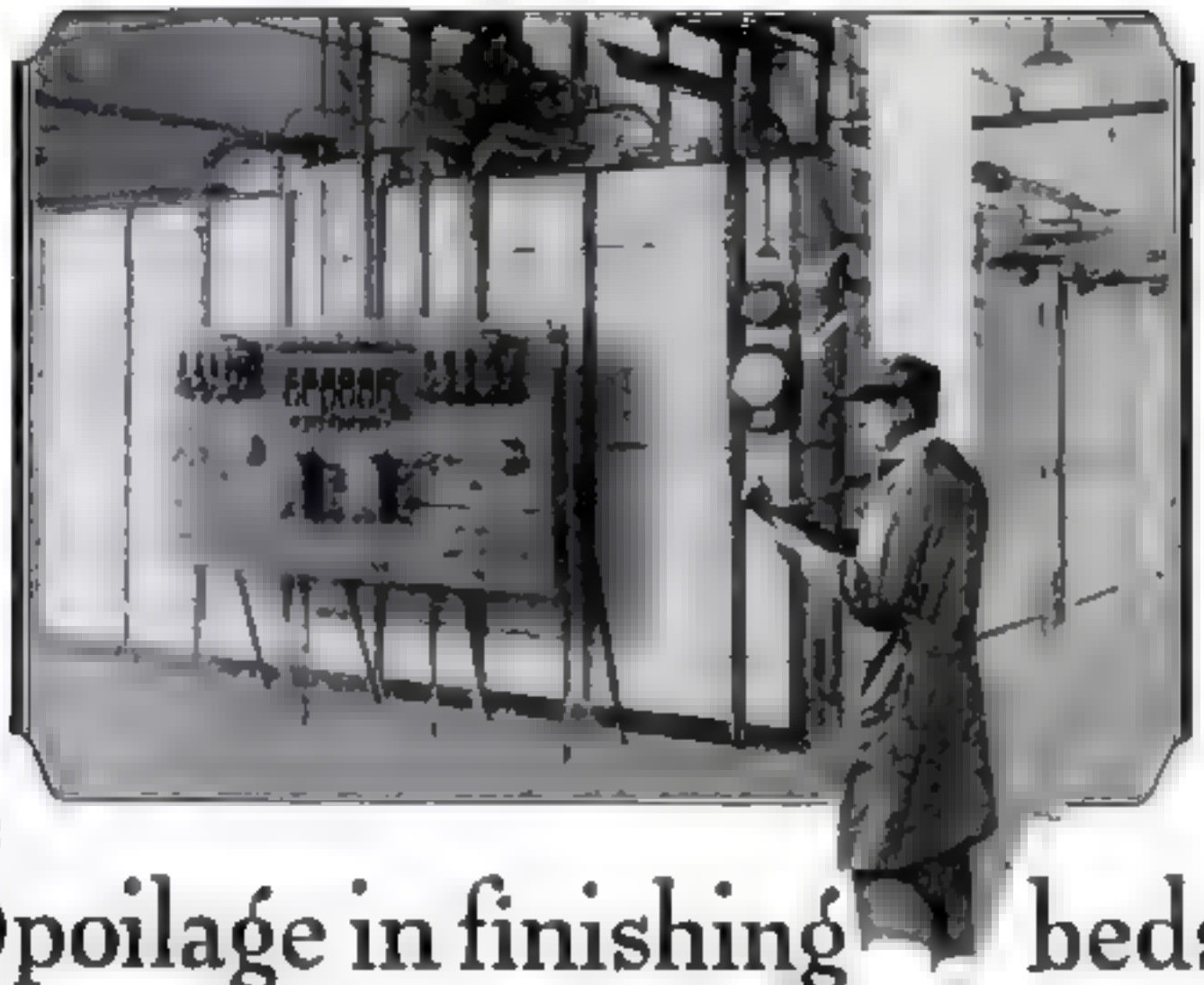
At times it is necessary to remove the old paint before an object can be repainted. The removal of paint on work of importance is usually accomplished with a commercial paint and varnish remover, except in the case of house paint, which is burned off. Much cheaper than commercial removers is a mixture of soft soap and burned and powdered lime (calcium oxide), to which an inert material like sawdust, flour, starch or chalk is added. This saponifies the paint and varnish, loosening it so that it may be easily scraped off with a dull knife or scraper. The surfaces then must be washed thoroughly with water. The mixture stains the wood to a certain extent, especially any wood rich in tannin like oak. This may be overcome, after the paint has been removed and the wood washed with water, by applying dilute sulphuric acid, made by pouring and stirring two parts of the acid slowly into eight parts of water. The acid neutralizes any alkali remaining in the pores of the wood, but it, in turn, must be removed by washing with water.



When white paint has a yellow tinge a few drops of ultramarine blue oil color in tube color will neutralize it

Other solutions, such as the commercial removers, merely dissolve paint without affecting the wood in any way. The chemicals used, however, are more expensive and require two or more applications, especially if the paints are very hard. Among them are the lighter petroleums, carbon bisulphide, acetone, wood and grain alcohols, carbolic acid and chloroform. Some of these are volatile, others are poisonous, while others are combustible. Four formulas are

(1) Equal parts of acetone and carbon bisulphide, with 2 oz. of paraffin added for each quart of mixture. The paraffin prevents too rapid evaporation after the remover has been applied. The mixture should not, therefore, be brushed more than is necessary, as brushing disturbs the film of paraffin. (2) Three parts of amyl alcohol and one of grain alcohol. (3) Four parts of grain alcohol, six of gasoline and one of amyl acetate. (4) Five parts of alcohol, five of benzol and one half part of amyl acetate.



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IT IS easier to spoil the finish on a bedstead in an enameling oven than it is for the housewife to burn a pie. Underheating means a *soft* finish; overheating means a burned finish—either means the finish on the products being enameled is ruined.

Whether you make enamel bedsteads or bon bons, steel girders or doughnuts, if your products go through heat treating processes in their making or finishing it will pay you in *money saved* to substitute the accuracy of *Tycos* Indicating, Recording and Controlling Instruments for the guesswork of the human senses.

Through the use of *Tycos* Indicating, Recording and Controlling Instruments, a Creamery saves $4,800 a year . . . a Manufacturer of automobile tires saves $10,000 a year . . . a Leather Company saves $936 annually . . . a maker of silk by the cupra-ammonia process saves $22,000 a year. These are definite savings testified to by manufacturers who have reported them to us. It will give us pleasure to give you the names of these manufacturers, and dozens of others who are making savings like these.

Possibly big savings similar to those made by these manufacturers can be made in your plant. It will commit you to nothing to consult with our engineers. *Tycos* Instruments for Indicating, Recording and Controlling are made in 8,000 varieties to fit all needs. We will be glad to supply you with informative literature on type of instruments you may be interested in. Or our engineer will consult with you on the application of *Tycos* to your particular manufacturing problem.

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Tycos Temperature Instruments

INDICATING · RECORDING · CONTROLLING

Wood Turning Simplified

(Continued from page 109)

heavy. To sharpen this type of chisel, place the bevel in contact with the oilstone, raise the chisel and slowly move it back and forth, pressing on the blade with the left hand. Reverse the chisel, place it absolutely flat on the oilstone, press on it with the left hand, and move it back and forth a few times. Repeat the process until the wire edge is removed. Test the sharpness of the tool on the thumbnail as in Fig. 1. If the tool is sharp it "takes hold", if it is not sharp, the nail slides over it.

The skew chisel is ground so that two bevels are formed instead of one. The cutting edge should be at an angle of about 65 degrees to the side of the chisel. While grinding, grasp the handle firmly in the right hand, press down on the blade with the left and hold the chisel at such an angle that the cutting edge is parallel with the axis of the grindstone or emery wheel as in Fig. 4. Whet the chisel on the oilstone.

THE parting or cutting-off tool has two teeth, which should be of equal length and meet in the ridge that runs through the center of the blade. If they do not meet at this point the tool will bind and stick in the wood.

The round-nose chisel is ground in much the same way as a gouge, and the diamond-point or spear-point chisel is held on the stone at an angle so that its edge is parallel to the axis as shown in Fig. 4.

When a tool is used for scraping, its cutting edge dulls more quickly than when it is used for cutting. To overcome this disadvantage and also to make the tool cut better, the edge is sometimes turned with a burnisher so that it forms a sort of miniature hook or burr. This is done after the tool has been sharpened as explained above. A good way to turn the edge is to clamp the tool in a vise and stroke its edge with a burnisher. The first stroke should be at about the same angle as the bevel. In the following strokes the burnisher is gradually raised, so that at the last stroke it is held almost in a horizontal position. See Fig. 5. It may be of advantage to turn the edge of square- and round-nose chisels and diamond-point chisels. The gouge and skew chisel are cutting tools and should not have their edges turned, neither should the parting tool, which has two bevels. The burnisher illustrated in Fig. 2 was made by grinding the teeth off a triangular saw file.

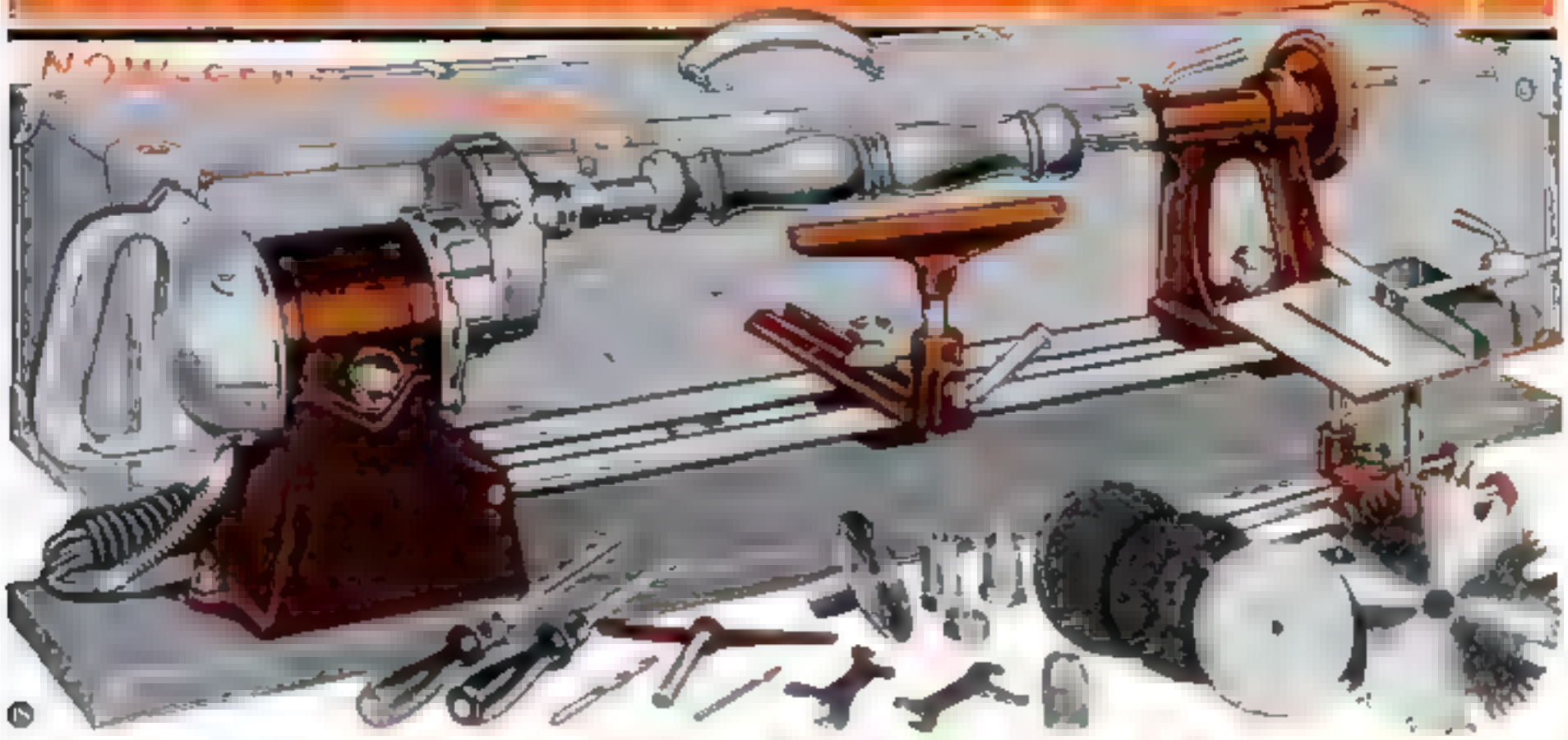
The oilstone and slip stone are hard smooth stones used for whetting tools. Machine oil thinned with kerosene is a good lubricant to use on them.

This is the first of a series of articles on wood turning. The second will describe in detail how to do simple spindle turning. In preparing this material for POPULAR SCIENCE MONTHLY, Mr. Hjorth has drawn upon extensive teaching experience. He is now an instructor in the Architectural Laboratory of the Saunders Trade School, Yonkers, N. Y., and formerly was General Supervisor of Manual Arts and Director of Technical Work in Porto Rico.

A WIDTH SIZE horseshoe magnet is an aid around the workbench for picking up tacks and small nails and screws that have fallen into the sawdust and shavings. With the aid of the magnet a whole box of tacks which have been spilled can be picked up quickly.—C. B. W.

BY WIPING NICKEL-PLATED hardware or other nickel-plated parts with a cloth moistened with a solution of one part sulphuric acid and fifty parts alcohol, rusting quickly with clear water and drying immediately it is possible to preserve the finish in its original brilliancy longer than if abrasive polishes are used.

The Modern Craftsman's Wonder Shop



New 1928 Red Jacket Assembly

Five Thousand Red Jacket Craftsmen have made a bargain possible for you

Without Waco sales volume, no manufacturer could give the equivalent of *"Waco Shop No. 12"* at its price—*A Red Jacket Master Drill*, the *Waco Craftsman's Lathe*, the *electric power tools*, the *Jig Saw*, the *Red Jacket Band Saw* or the Crafts Courses.

This equipment was designed, tested, approved and is guaranteed by Wm. L. Aylward, a nationally known craftsman and manufacturer, who has developed his hobby into a co-operative association of five thousand craftsmen.

Portable—Interchangeable—Complete HOME WORK SHOP

The new 1928 Combination of Electric tools brings you a Red Jacket Band Saw and in addition the powerful Red Jacket Master Drill Motor with direct drive to the Waco Craftsman a wood turning lathe (capacity 9 in. x 30 in.) a bench saw that has depth and mitre gauges, scroll and jig saw and all accessories for both portable and stationary power drilling, buffing, grinding and cleaning. Attaches to any light socket and converts your work bench into a complete private tool and machine shop.

It is a complete chest full of electrically driven tools designed by a master for the private use of tool lovers and men who create, repair and appreciate handy tools at home.

The Waco GUARANTEE

If It Is Not What You Want When You Get It—Send It Back.

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Write or send coupon at once for valuable information to all interested in better full handiwork. It is free. It tells you how easy it is to operate a Red Jacket set of tools and lists the advantages and privileges that are free to member craftsmen.

It is a real thing knowing all about Waco. It is free. You are invited.

Look out for imitations. There is only one Red Jacket—one Waco—one Wm. L. Aylward, Mastercraftsman.

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SPECIAL CRAFTS COURSE and blueprint service is free to Red Jacket Shop owners—all that there is to know about handicraft methods, raw materials, woods, carving, staining, turning, designing, carpentering, decorating, is taught by special correspondence.

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Only $10.00 down. Liberal discounts for cash. Easy monthly payment plans. It is no hardship to own a Red Jacket.

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This Headstock furnished where no electricity is available.

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The most elaborate and universal drill motor ever designed as driving power.

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Manager, Dept. 3. Please send me all free information and literature on Red Jacket Assemblies.

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This seal on a radio, tool or all learner advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Powering Your Set

(*Continued from page 84*)

filed so that it will fit into the slots in the screws. This screw driver is necessary for two reasons: First, it eliminates hand capacity and makes balancing much easier. Second, it prevents the chance for a short circuit that otherwise would occur if the blade of an ordinary metal screw driver accidentally touched the shield or any other metal part while in contact with the screws on C4 and C5.

To balance, turn the drums to about 30 and set them so that the squeal is as loud as possible. Put the top on shields N3 and N2. Turn the screw of C4 with the special screw driver until you find a point where there seems to be a radical change in the squeal—a fluttering or broken effect. Now put the top on N1 and take off the cover of N2. You will find that by turning the screw of C5 you will come to a point where the squeal disappears. If it does not, turn the screw in C4 a trifle, first one way and then the other, and again readjust C5.

IT WILL pay you to take your time about the balancing and do it just as accurately as possible. As you have noted from the description of the electric receiver, the primary coil of each radio-frequency transformer (A1, A2 and A3 of Blueprint No. 79) moves away from the secondary coil as the condenser is tuned to the lower wave lengths. In laboratory tests it has been found that the receiver is just as selective at the lower wave lengths as it is at the higher waves. This means, of course, that the tuning is sharp at the lower waves. Incorrect setting of the balancing condensers C4 and C5 may upset the tuning on the short waves where a slight difference in capacity makes such a great difference in dial setting.

You may, for instance, get one balancing condenser set with a trifle too much capacity and the other with a shade too little. With such an adjustment you may find that there are two distinct points on the dial for each low-wave station. The remedy, of course, is to reset the balancing condensers until the double peak disappears.

ONCE these adjustments are made, you can push the set into the cabinet for it will require absolutely no further attention until a tube gives out. As all these tubes are rated at 1000 hours of service, you probably will not have to touch the set except to turn it on and off and tune it for at least a year.

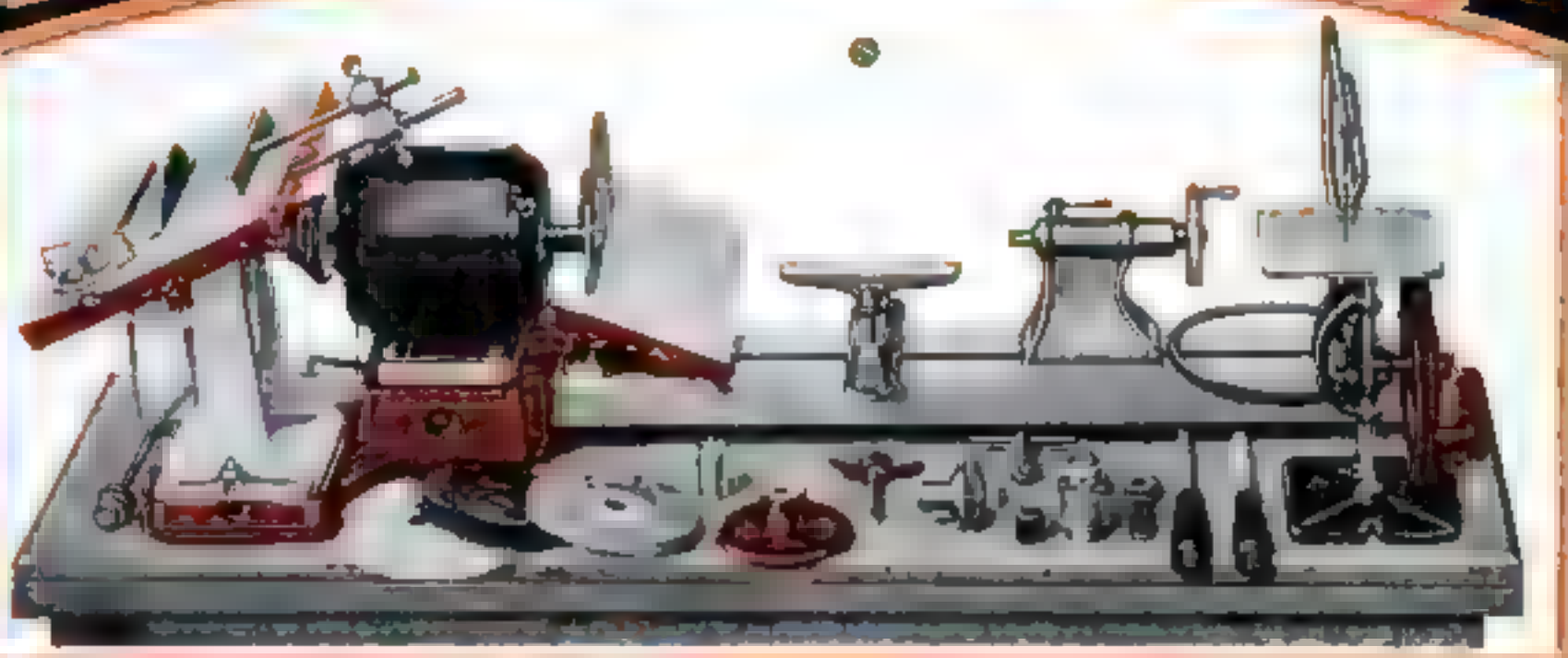
The volume control R9 will give you a perfectly smooth, distortionless control of volume on radio reception, but it has no effect on the volume with which phonograph records are reproduced when the phonograph pick-up unit is plugged into jack J. However, a special volume control is a part of the equipment that is matched with the pick-up device. To use the pick-up device simply turn on the set in the usual way, plug into jack J and start the needle on the record. To amplify your own voice just plug a pair of headphones into the jack and talk into one of them. You can make up all kinds of special programs to amuse your friends by doing your own announcing and playing records for the musical part of the entertainment.

The Parts to Use

The high power amplifier and current supply unit was designed without regard to expense for the radio fan who desires to build the finest possible outfit. In addition we wished to provide, as far as possible, for future developments that might make a still more powerful amplifier a practical possibility. This accounts for the 750-volt winding on the power transformer and the use of 1000-volt condensers in the filter circuit. Should a new and more powerful amplifier tube be brought out that required a greater voltage than the 210,

(*Continued on page 118*)

Delta Handi-Shop



No Continuous Breaking Up of Operations

Because of its unusual and practical design the Delta Handi Shop has overcome one of the greatest drawbacks in the average workshop the continual breaking up of operations. The Delta has a two shaft motor, therefore two tools are always ready for work Suppose you are using the Circular Saw Mounted on the other motor shaft is the Sanding Unit instantly ready for work. Think of the convenience—the big saving in time and unnecessary work There are numerous other tool combinations that can be arranged easily and quickly on the Delta Handi Shop as the combination described above

Remember the Delta Handi Shop is a BIG, STURDY, PRACTICAL workshop for home or commercial use. It cannot be classed in any way with the so-called portable shops Think of a lathe bed of 4-inch U-section that is 36 inches long—48 inches long if you prefer—that will not chatter or spring. Think of a big, husky, fully-enclosed powerful motor with a great overload capacity. Think of every accessory, and there are plenty of them, which are of the best quality obtainable—every one a nationally-known product

We have built real machine-value into the Delta so that you can do the finest kind of work on it with amazing ease

People who buy it say that it is far better than they expected a workshop could be but you should see the shop itself and work with it to fully appreciate its outstanding qualities its many novel and appealing features.

If You Are Fond of Good Tools

Send for our illustrated color folder. See how easy it is, with the Delta Handi Shop, to gratify your desire to do more and better work. See how easy it is to do those things that no shop but the Delta has ever been able to do. Think of the money you can earn in full or spare time. How you can increase your profits by furnishing your employees with a real shop unit. Let the Delta help you develop your creative and inventive ability Spend interesting, healthful, happy hours in using it in many ways you never dreamed of before.

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858 3rd St., Milwaukee, Wis.

Send me your illustrated color folder describing Delta Handi Shop Tell me about your Free Trial Offer Free blue prints and Easy Payment Plan.

Name

Street Address

City State

Powering Your Set

(Continued from page 115)

this outfit could supply it merely by changing a few connections.

The power amplifier unit described here is, however, capable of such great volume with practically perfect tone quality that it is doubtful if any greater volume would prove of any practical value except in special cases.

It is quite possible, therefore, to materially reduce the cost of the unit by using less expensive filter condensers and the capacity also can be reduced without affecting the tone quality to any appreciable degree.

The condensers C1 to C6 as listed, that is, of 2 mfd. capacity rated at 1000 volts D.C. working voltage, cost in the neighborhood of eight dollars apiece, which would make the cost of the necessary condensers for the whole unit approximately fifty to fifty-five dollars.

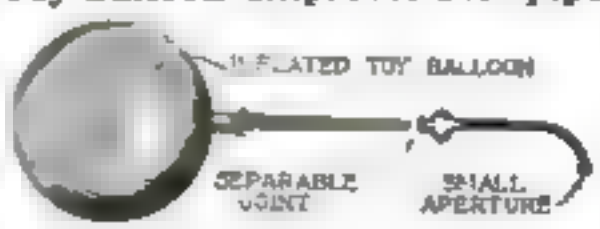
BY ELIMINATING condensers C2, C4 and C5, you can save about twenty-five dollars, and a still greater saving can be made by using one of the standard block condensers specially designed for this type of circuit. Careful laboratory tests have shown that while there is a slight increase in hum when the condenser capacity is cut down, this difference is so small that it cannot be detected by the human ear. These various factors have been taken into account when making up the list of approved apparatus and the various types of condensers that are suitable for use in the circuit have been listed.

The reason that a 41,000-ohm resistance is specified although part of it remains unused is because standard units of this resistance are available. They are tapped at the proper points. Fixed resistances have been specified at R1, R2 and R3 because the unit has been designed to work with the electric radio receiver of Blueprint No. 79. You can, of course, use this power amplifier and current supply unit with any type of radio receiver if desired. If you have a battery set, disregard the 1½- and 6½-volt windings. The binding post marked P of the power unit should be wired to the P terminal of the first audio amplifier tube in your set, thus cutting out the second stage of audio amplification in your set. Do not attempt to use the complete two stage audio amplifier in your set with the power stage added to it. This combination is, in practically every case, absolutely unworkable.

Your battery operated receiver may require B-voltages differing from the electric set of Blueprint 79. If so, any desired B-voltages may be obtained by using at R1 a wire wound resistance unit fitted with clips that can be moved to change the voltage.

If any details of the construction, wiring or operation of the complete outfit are not clear, explain just what additional information you desire in a letter addressed: Radio Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Toy Balloon Improves Blowpipe



A two-piece mouth blowpipe with balloon attached to insure a steady, even blast of air

WHEN you have work that requires the use of a mouth blowpipe, obtain one of the two-piece variety. Attach an ordinary ten-cent balloon to the large end with a rubber band, disjoint the blowpipe, inflate the balloon and reassemble the blowpipe. Then you will have a steady blast. T. M. Barnes.

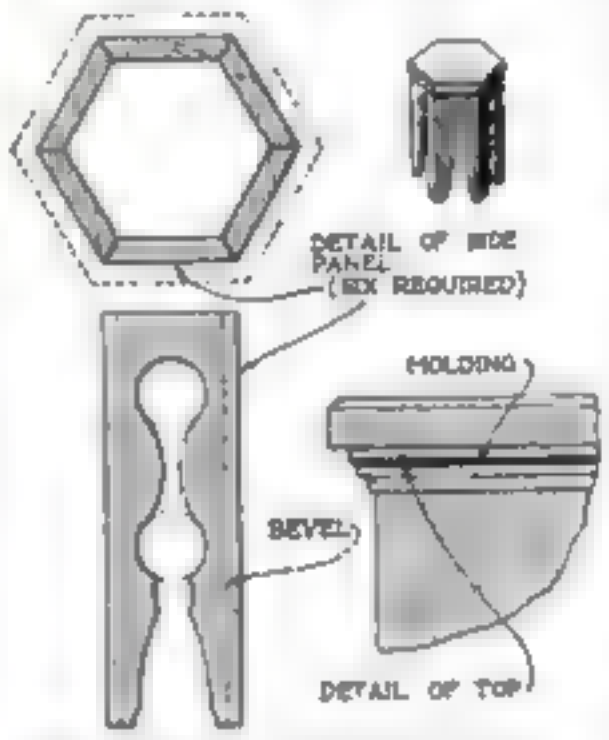
A Small Plant Stand Anyone Can Make

A SMALL ornamental plant stand of the type illustrated can be made easily by the amateur woodworker

While stands of this type can be any size, one 14 in. high, 9½ in. across the top, and 8 in. across the base will be described. The wood is all ⅞ in. thick.

The core block, which goes just under the top, is inscribed in a 6¼-in. circle. Draw the circle and, using the same radius, step around it with the compasses and connect the points with straight lines. Then saw out the hexagon.

The six pieces that are to form the base may be beveled in one length and cut into sections that measure on the outside when finished ⅞ by 4 by 13½ in.



How the sides are cut out and assembled and the top is trimmed with a stock molding

Any suitable design may be cut out with compass, keyhole or fret saw. The one shown can be produced by boring two 2½-in. holes and cutting out the remaining parts with a small saw, but the work must be firmly held in a vise or with hand screws to prevent splitting.

To assemble the base, place one section in the vise, apply liquid glue of good quality, and attach another section with two or three small brads. Make three pairs in this way. Now, keeping the core block slightly below the top, glue and nail the parts lightly together. After the glue is hard, sandpaper the surface but do not round the edges.

The top is a hexagon inscribed in a 9½-in. circle and is either nailed or screwed from beneath the core block. A stock molding is fastened beneath the top. If an adjustable miter box is not available, a small miter block may be made for cutting the angles.

If the stand were made higher and somewhat larger, the core block might be lowered several inches and the top hinged, to make a lady's worktable.

If made of hardwood, the stand can be stained and varnished or finished with clear brushing lacquer; if of softwood, it can be painted with colored brushing lacquer. A. E. ELLING.

A definite program for getting ahead financially will be found on page four of this issue.

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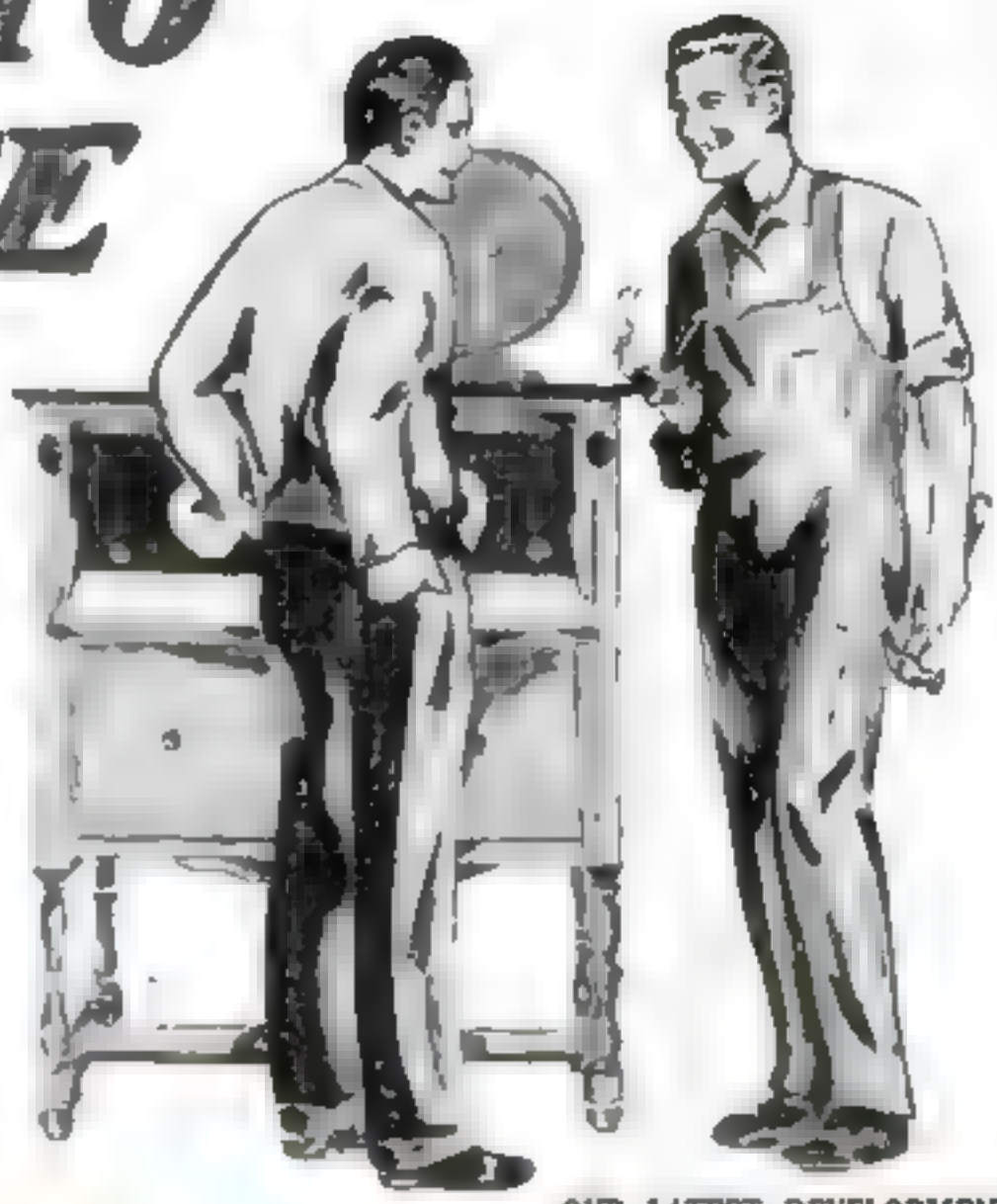

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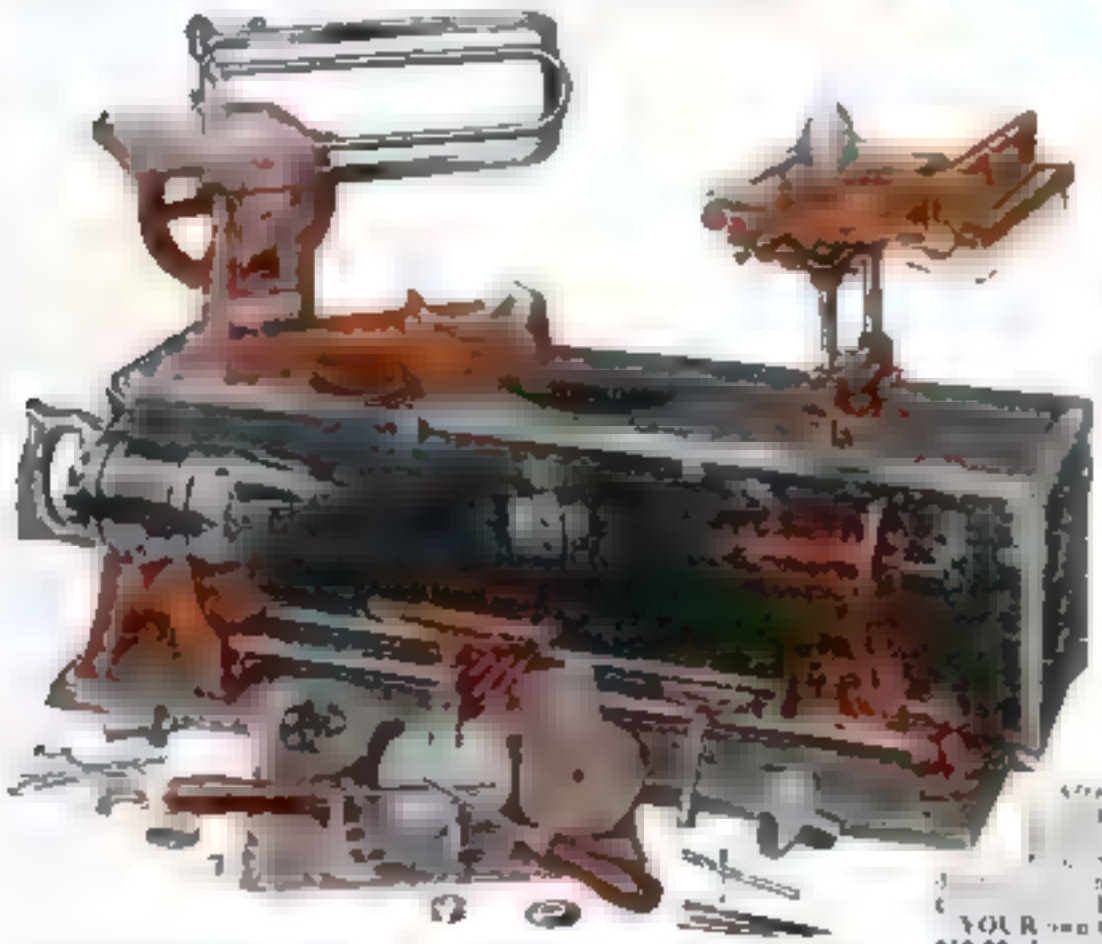

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How to Lay Out Your Shop

(Continued from page 91)

vise mounted on it. As the vise is also used for many filing operations, wire drawing, and many other things, the height of the jaws from the floor should be carefully considered.

The six legs are made of 4 by 4 in. lumber, the rest of the framework may be made of from 1 to 1½ in. thick boards, 6 or 8 in. wide. If the bench is to be a short one, say 3 or 4 ft. long, four legs will be enough. The top should be of hardwood, beech or maple if possible, and 2 in. or at least 1½ in. thick.

A strong bench will result if it is simply nailed together with heavy spikes; or the frame may be bolted together, the top being held with countersunk lag screws. If you are fond of woodworking you may make the whole affair with mortise and tenon joints, but it is not at all necessary.

Each of the legs is firmly fastened to the floor with angle irons, and the bench should be also held firmly to the wall with angle irons, if possible.

The planks forming the top should be fitted together as tightly as possible and planed smooth. When the bench is finished, the top should be given one or two coats of boiled oil, and the framework painted some attractive color.

The leg of the blacksmith's hot vise extends into a hole in a block of wood firmly fastened to the bench leg and floor. The vise should be fastened to the bench top with heavy bolts, the front edge of the bench being notched out, if necessary, to receive a part of the back leg of the vise. A bench drill is a useful tool to have on this bench.

Notice that the shop layout is planned so that there is room between the two benches; one may work at the end of the vise, standing between the two benches, as one often finds it convenient to do when engaged in hammering out bowls and trays.

The advantage of a blacksmith's vise is that it is made of wrought steel and is very strong. Considerable pressure must be put on vise jaws to hold a stake firmly under repeated hammer blows, and the more finely made machinists' vises, while they may be used, will not usually stand up under the work, being made of cast steel or iron. There are many other uses for a heavy vise in the shop as will be noted later on.

THE heavier the vise is, the better. The one which I use has jaws 6 in. wide, and the whole vise weighs about 120 pounds. I have had and used it for longer than twenty years, and we have tackled some heavy jobs together.

Vises are usually sold and listed by the width of the jaws parallel with the handle. If you buy a vise of the blacksmith's type, get one with at least 4-in. jaws; one with 5-in. jaws is better, and one with 6-in. jaws best of all. This kind of vise, if not sold by your hardware dealer, can be obtained reasonably from any of the large general mail order houses.

Of course, if you already have a machinist's vise of good size, you may use this, or devise some other method of holding the stakes as shown in Fig. 2. At A is a tinsmith's bench plate such as you may have seen in a tinner's or coppersmith's shop. This is a heavy slotted iron plate with a number of rectangular holes or slots. It is let into the bench top, and the wood underneath each slot is cut out to correspond with the taper of these slots, so that the tapering ends of the stakes or anvils are held very firmly. This is a very old and satisfactory method of holding stakes. Bench plates of this sort may be obtained from dealers in tinsmiths' supplies. It is well to get the catalog of such a firm, as you will find many stakes, anvils and other special tools for the use of metal workers.

Another method of holding stakes is shown at B. It is perhaps the oldest and best method of all, if you have room for it. A large log or stump of hardwood—maple or beech—is fastened to the floor of the shop with angle irons. In the top of this log, which is about 30 in. up from the floor, is cut one or several tapering slots to fit the tapered ends of the stakes and hold them firmly for hammer work. This is the most noiseless and inexpensive way of holding stakes for making bowls and trays. Many metal workers who live in the country have several of the logs set in the ground in some pleasant location outside the shop, where they work in the summer. Shallow hollows may also be carved in the top of the logs for embossing bowls, forming spoons and so on.

At C is shown the common method of holding stakes or anvils in a heavy vise. This method has the one advantage of allowing the worker to tip his stakes at various angles to suit the work.

Iron pipe or steel bars of different lengths and diameters may also be held in the vise and used as anvils or stakes. You will find a collection of short lengths of pipe and round or square steel bars from the junk yard extremely useful.

A regular stake holder mounted on the bench top is shown at D, Fig. 2. These holders are often sold with sets of stakes. A piece of thin leather slipped between the stake and the holder tends to make the stake hold more firmly and lessens the noise somewhat.

RETURNING to Fig. 1, you will see a rack for stakes back of the bench for heavy work and just under the window. If the stakes are to be hung on a flat surface, such as in a closet or on a wooden wall, heavy harness hooks form excellent holders, two being used for each stake, just as a hammer is hung on two nails. Another excellent method of holding stakes is to screw a length of old leather or rubber belting, about 1½ in. wide, to the wall so that loops are formed. Metal washers should be placed under each screw head.

On the bench for heavy work is a small bench anvil. An old flatiron with the handle broken off makes an excellent substitute.

Between the benches for heavy and light work, mounted on the wall, is a pair of large bench shears for cutting heavy sheet metal. The end of the lower handle or leg may be set in a slot in the bench top or bench plate or held in the vise. Above the bench shears is a large pair of hand shears or tinner's snips.

Two wooden mallets also will be seen. One is an ordinary wooden mallet of hardwood, one face being flat and the other dome shape or round for embossing or raising. The other mallet, or raising hammer, is square in section and tapered to a blunt point at one end. This form is much used in the preliminary stages of raising certain types of copper bowls and trays.

It is worth remembering that wooden tools are much used by the professional metal worker, as they leave no marks that may not be easily removed or worked out later on.

Above the mallets are mounted special forms of silversmiths' or coppersmiths' hammers for embossed and raised work.

The bench for light work or jewelry making should be built solidly although it is of much lighter construction than the other bench. Suitable dimensions were given in an illustration that accompanied the first article in this series, but the size can be varied to suit the shop space. The

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How to Lay Out Your Shop

(Continued from page 122)

height from the floor to the bench top is planned to suit the convenience of the worker when seated at the bench—usually between 30 and 31 in.

THE four legs may be made of 2 by 4 in. lumber, the other members of the frame being 1 by 6 or 1 by 8 in. boards. The top preferably should be of hardwood such as maple or beech, 2 in. thick. A semicircular piece is usually cut out of the front edge of the bench top, about 5 in. deep and 16 in. long. This allows the bench pin, described last month, to be mounted, as shown, conveniently over a leather apron or "skin," which catches silver or gold filings. Sometimes a zinc-lined drawer is arranged to slide in and out under the bench pin to catch filings, but many jewelry makers prefer the leather skin. This may be of genuine leather or one of the durable, smooth leather substitutes used for chair or automobile cushions. Small hooks are arranged under the bench so that the skin will hang baglike under the bench pin and yet not interfere with sawing the work.

On top of the bench at the left are two gas connections, cocks with rubber hose attachments, one being connected to a Bunsen burner and the other to a mouth or "combined" blowpipe. If you have no gas in your shop, you may use an alcohol chafing dish lamp instead of a Bunsen burner and an alcohol blow torch in place of the gas blowpipe, as I do in my own shop.

A very small pair of jeweler's snips or shears is hung on the front right leg of the bench. It is a good plan to have a small bench vise of the demountable kind, which may be clamped to the front edge of the bench when needed.

The tool rack at the back of the bench is simply a piece of soft wood ¾ in. thick, 2 or 3 in. wide and as long as the bench. Slots are made in it for files, and holes are made for the other small tools such as scriber dividers, pliers, and tweezers. When the bench is finished, the top should be oiled and the underpart painted.

The foot power polishing machine, also described last month, is shown on the extreme right. On the wall back of it are hung the various emery wheels, polishing and buffing wheels, and wire scratch brushes. The polishing machine should have a good working light.

ALTHOUGH not shown, or absolutely necessary, a blacksmith's anvil weighing from 75 to 150 lbs., solidly mounted on a heavy wooden block, is useful. Such anvils are best mounted on a heavy section of a tree trunk, the lower part of which is sunk solidly in the floor, if the floor is of earth as in most blacksmiths' shops. If this is not possible, the anvil block should be held to the floor with heavy angle irons. A skilled metal worker can make almost anything on such an anvil.

If you cannot manage to have a real blacksmith's anvil, you may care to invest a few dollars in one of the very reasonably priced cast steel farm anvils sold by hardware dealers and mail order houses. These cast anvils range from 50 to 100 lbs.

If your shop is a small one, you may get along perfectly well with an improvised flat iron for an anvil, or a small bench anvil and pipe or steel bars held in the vise. If you really want to do a thing badly enough, you will manage it somehow. In metal working or any other craft, the secret is to know just what you want to do and how to do it; then you may improvise many ways of doing it and adapt the tools of one trade to another, as you will see further along in this series.

The fourth article in Mr. Thatcher's series will appear in a forthcoming issue.

The Exterior Setting

(Continued from page 94)

on brackets. The window has shutters made useless by overhanging rose vines in bloom. In back, at right angles to the wing of the house, the garden is bounded by a clipped hedge with irregular flower planting set against it; and just before the hedge encounters the left boundary of the stage, a rose arch and a gate mark the entrance to the garden. Beyond this hedge and gate one gets a view of meadows with trees and a glimpse of distant houses. On the left of the stage and opposite the door into the house is a garden seat with an awning top in front of this seat are a table and a chair. A rose lattice showing a profusion of blossoms is in back of the seat. It is high enough and wide enough to screen and shut from view the adjoining orchard.

SO MUCH for the written description. Now let us make a rough sketch plan—just a few hastily drawn lines to indicate the general arrangement. The essential elements of the setting are indicated at *A* in the lower illustration on page 94; they are shown rearranged at *B* with the idea of making a better stage picture. For the sake of the composition I have added a tree at the corner of the house.

Next it is desirable to make a rough perspective sketch. If this seems to satisfy the requirements of the script, we had best draw a plan accurately to scale and from this plan work up the stage model.

The making of a model of an exterior set will call for a little more painstaking attention than is needed in the construction of an interior set such as that described in a previous article (December, 1927, issue). As the various elements of the setting are individual pieces, they will have to be set up separately instead of in the self-supporting continuous strip that forms the side of a model of a room interior. In locating the elements, make sure they are placed so that they will inclose the entire scene and, when viewed through the proscenium arch, leave no gaps and openings into the back stage. This is an important function of the model. When the enclosure has been worked out in the model, the scenewright can rest assured that his actual set will be "eye-tight," provided the stage model is accurately enlarged.

In painting an exterior set it is always best to handle the work in a free, decorative way. Even at the best the outdoor setting is a convention. It can never look as convincing as an interior, but the audience is always ready to accept a compromise between nature and art, especially the art of an amateur. The best that the scenewright can hope for is to suggest the out-of-doors. And for this reason he is perfectly justified in giving the set a posterlike simplicity, showing his tree forms in frankly angular outlines, and painting his foliage in mass rather than in detail.

IN THE actual construction of the exterior setting I find that building paper is again a useful economy. On page 94 are shown the backs of two cut-out tree forms. The same method can be used for the frame of a hedge. For work of this sort it is often better to double the thickness of the paper, or use an extra heavy building paper.

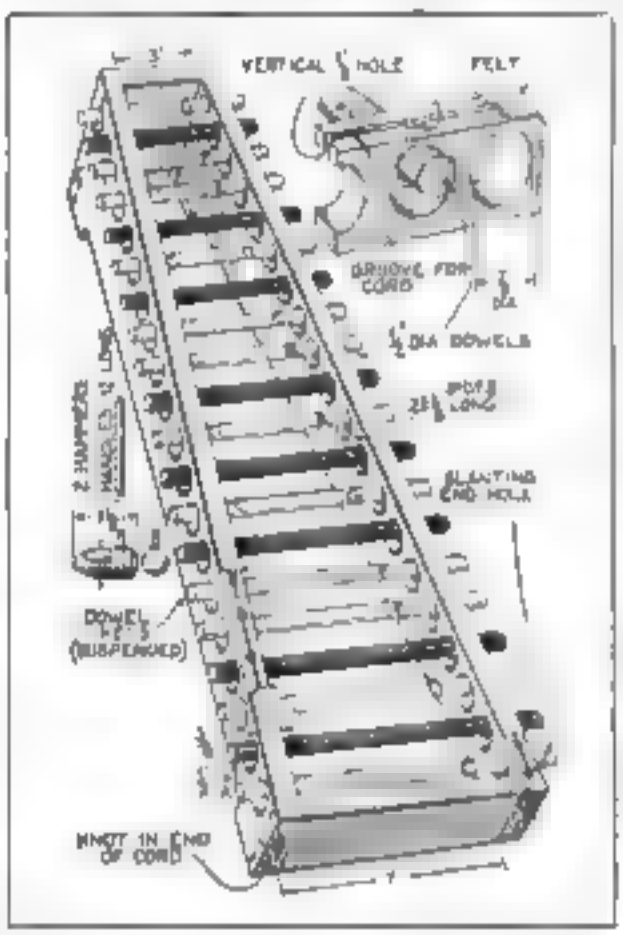
In designing a set the scenewright must keep in mind a plan for lighting it. In the problem which we have been discussing the back drop can be lighted from the line of the hedge; the tree at the corner of the house will lend its upper branches for the concealment of these lights; and the hedge itself will serve to hide a string of floor lights.

The scenewright must realize that in an exterior setting the lighting will be his chief aid to the illusion of space. He must plan for it from the start. If it has been properly worked out his setting will come to life.

Dowel Sticks Serve as Xylophone Keys

THE music of the xylophone in either solo or ensemble playing has a piquant quality that makes the time spent in learning to play it well worth while. First it is necessary to obtain an instrument on which to practice, but that is not difficult. Any handy man can make a satisfactory xylophone of the type illustrated. It has a chromatic range from C to G of the octave above inclusive.

Any kind of wood may be used for the box. The keys are made of dowels. Make two sides ⅜ by 4 in. (tapered to 2 in. at one end) by 23¾ in., one end ⅜ by 2 by 7 in. and one end ⅜ by 4 by 3 in. Bevel



The assembled xylophone and details of the hammers and the method of supporting keys

the ends of each of the short pieces slightly to join the sides neatly.

On a line ⅜ in. from the top edge bore twenty ⅜-in. holes 1⅛ in. from center to center. In doing this place the sides under pressure in a vise or hand screw to prevent splitting. Use a center or a Forstner bit.

Drill a ⅛-in. hole in the top edge vertically above the center of each large hole and a slanting hole at each end. Assemble the box with 1¼-in. brads.

Make the keys of ½-in. dowels, maple preferred, cut them somewhat longer than required. Tune with a piano or other instrument of permanent pitch, beginning with the lowest note. Make a key sharp by cutting from the end, or flat by putting a saw cut in it. Stain the sharp keys with black ink or dye, but use neither shellac nor wax. Cut a groove in the upper edge of each side piece to receive the cord.

The heads of the hammers may be made of a ⅜-in. dowel and the handles of a ⅛-in. dowel.

Stain and finish the box as desired, or not at all, but do not touch the top edges of the sides with oil or wax, for the last thing to do is to glue on a piece of felt to cover the cord.—C. A. K.

How to Care for Your Tools

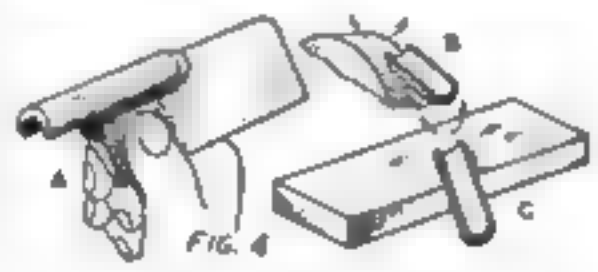
(*Continued from page 86*)

with a try-square, which would be slower.

The edge of a chisel should be ground square across as at *D*. A jack plane or a angle-iron plane for rough work should be well rounded as at *E*, while the edges of a smoothing plane iron or of a spokeshave iron should be shaped about like *F*. The edge of the jointer plane should be slightly elliptical as in *G*. In all the sketches the curves are somewhat exaggerated.

Assuming that the edge of the grinding wheel is perfectly straight and true the edge of the cutter should be carried squarely across as at *H*, the wheel always turning toward the edge. Keep the tool moving from right to left. Grind until the cutter is in its correct relation to the edge of the cap iron and a wire edge may be seen the entire width of the tool.

Grinding is only preparatory to whetting or oilstoning. Use land oil or a light lubricating oil on the oilstone. Draw the cap iron back to the top end of the groove in the cutter and fasten it, as at *J*. Grasp the iron and cap in both hands as at *K*, place it across the stone at



Gouges beveled on the outside are ground and whetted by turning the hand continually, the wire edge is removed with a slip stone

an angle of about 30 degrees and raise or lower it as at *L* until the exact bevel is attained either by feeling or by seeing the oil that is squeezed out when the cutter is properly placed. Maintain this angle, carrying the tool back and forth the entire length of the stone. Guard against the tendency of the tool to "rock," which rounds the edge and destroys the bevel. Carrying the iron as at *K* should largely prevent this, but if it does not the worker will be justified in making circles and figure eights instead of straight motions.

When the beveled side has been whetted from fifteen to twenty-five strokes, the wire edge may be removed by a few strokes with the face of the cutter lying *flat*, in *perfect* contact with the stone as at *M*. Pressure is applied in the direction indicated by the arrows.

The cause of a clogged plane mouth, usually is a badly fitting cap iron as at *N*. Hold the cutter and cap so light may be seen through the faulty joint between them as at *O*. A very bad place may be remedied by bending, but the final fitting should be done with a flat file as at *P*.

Perhaps the top side of the cap edge may have become rounded by long use as at *R*, in which case it should be bent back and filed to the same curve as a new cap iron. Be sure that the edge is kept square with the sides. Note that the file at *P* slants *down* to make a thin edge. Place the cutter and the cap iron in position as at *S* and with the corner of a chisel press firmly against the outside of the joint, which will force the particles of steel into perfect contact with the face of the cutter.

In sharpening gouges the slip stone should be used, but unless used correctly with the hand well away from the cutting edge as at *A*, Fig. 4, an ugly cut may be received. Outside gouges may be ground on a grinding wheel by turning the hand as at *B* and whetted by the same method as at *C*.

The scraper prepares a planed surface for the sandpaper by removing the minute ridges between plane strokes; it also supplements

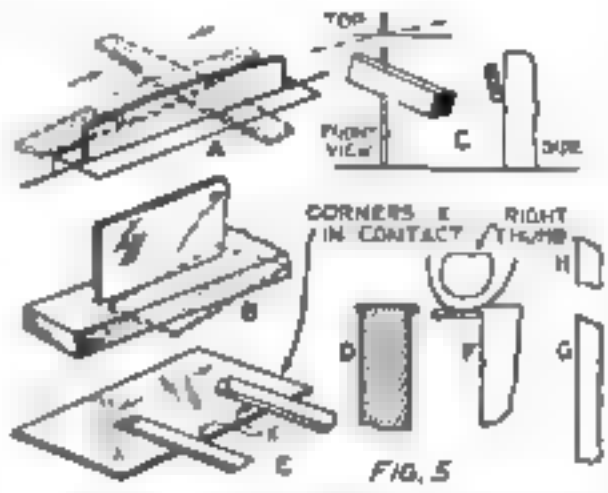


FIG. 5

A cabinet scraper is sharpened square across and the corners are then turned over a trifle

the plane in smoothing cross-grained pieces. The sharpening of a scraper is a knack to be acquired by practice. Place the scraper in a vise and file the edges square across and slightly rounding lengthwise as at *A*, Fig. 5. Hold the file either lengthwise or crosswise, but move it in the direction indicated. Whet each edge to two sharp, square corners as at *B*. Apply a little oil and hold the scraper as at *C*. The edge of a burnisher or the corner of a chisel is placed in contact with the edge of the scraper as shown. Point the burnisher or chisel down, keep it square with the edge, and make one light, firm stroke upward. Begin at the bottom and make a heavier stroke. Keep the angles shown exactly the same except in one respect, push the burnishing tool with the thumb in such a way as to incline it as shown by the dotted line. This will turn the corner or edge of the scraper as in the enlarged view *D*. All four corners may be sharpened.

IF THE scraper has been sharpened successfully it should cut a thin, clean shaving as wide as the worker has strength or skill to produce, but if a powder is *scraped*, the sharpening has been a failure. This may be the case if the edge has been turned over too much or because it has become dull. In either case it may be remedied by laying the scraper flat on the bench and rubbing the edge down as at *E*. Carry the burnisher at each stroke on the corner marked *X*. Then repeat the process of turning the edge.

If the edge has been turned too far the defect may often be remedied by carrying the burnisher the length of the scraper, under the edge and against the thumb as at *F*, then giving one light stroke as at *G*.

If a scraper is well rounded on an edge or end and file-sharpened at a bevel as at *G*, it will scrape paint effectively. If whetted and the edge turned over as at *H* it will do more satisfactory work upon floor scraping and similar rough work than the square-edge scraper.

In sharpening an auger bit, the underside of the cutter *A*, Fig. 6, should not be touched. The filing should be done upon the top of the cutter with a special bit file as at *B*, this file has smooth edges at one end so that lip *C* may be filed as shown at *D*. Do not file the outside of the lips.

(Continued on page 142)

FIG. 6

An auger bit is sharpened with a special file on top of the cutters and inside the lips

How to Care for Tools

(Continued from page 126)

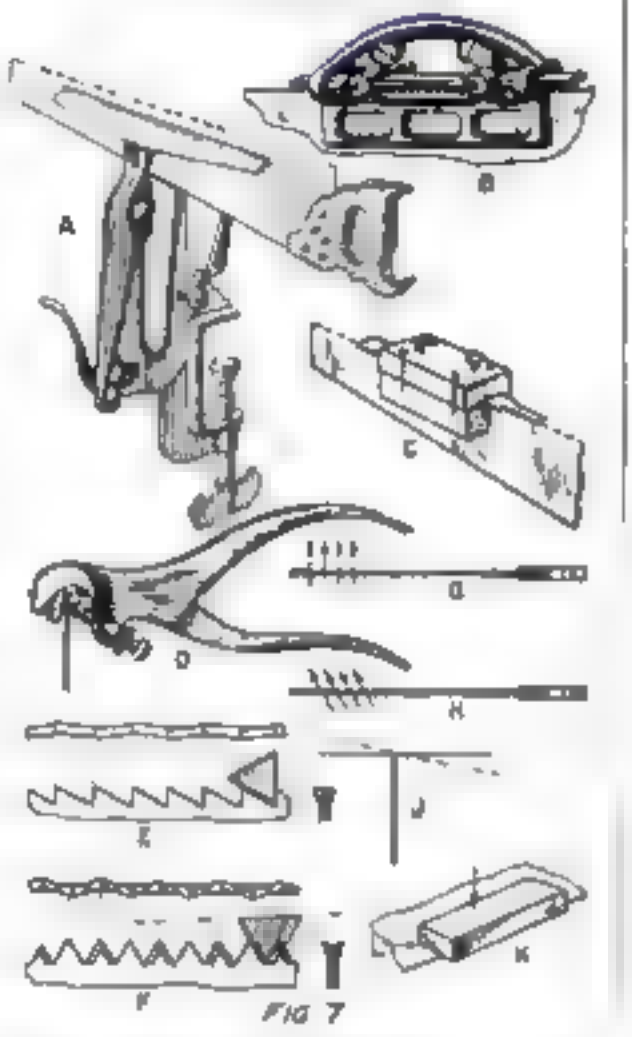


FIG 7

How the teeth of a rip saw (E) and a crosscut saw (F) are jointed, set and filed sharp

The average home worker had better sidestep saw filing unless he can practice upon a saw of no great value. We will assume, however, that our readers wish to go the whole distance. Place the saw in a saw filing vise as at *A*, Fig. 7. With a flat file held in a jointing device take one or two strokes lengthwise to "joint" the saw, or to make the teeth of uniform length as at *B*. A jointer may be made of wood as at *C*, though many workmen use the file free-hand. With a saw set *D* bend out alternate teeth for one third of their length from the point; then do the same from the other side. At this stage a rip saw should appear as at *E* and a crosscut saw as at *F*.

In filing a rip saw begin at the point and file every tooth square across, carrying the file at right angles as at *G*. Hold the file so the side which is filing the front of the tooth behind it stands vertical as at *E*. The amateur may find it easier to file a rip saw from each side, filing the teeth that are set away.

In filing a crosscut or cutting-off saw the file should be carried at an angle pointing toward the end of the saw of about 60 degrees with the saw blade as at *H* for a general purpose saw, rather less if for soft wood only. Many mechanics, however, point the file toward the handle.

THE file should be carried as at *F* to give each tooth "hook," which is a large factor of the "sweetness" of the cut.

The writer prefers to carry the file level as at *J*, although many prefer to lower the hand a little as shown by the dotted line. This applies to cutting-off saws and rip saws if filed from both sides, but in every case the teeth should be of uniform length. This may be attained by watching the glint of light on the end of the teeth where they were touched by the file when pointing them. Remove about half of the glint from each tooth from the first side and the rest from the other side.

Lay the saw upon a perfectly flat surface and carry a flat file or whetstone from handle to point over the teeth to remove the burr. Keep the pressure as at *K* so the stone will bear a little harder at the edge marked *L*.

Simplest Flying Model

(Continued from page 81)

is fitted into a notch at the rear of the fuselage and glued and bound into place. The other two sides of the tail frame are made of silk thread. Cut a very slight slit across the under face of the fuselage 5 in. from the tail end. Split one end of the tail spar and fasten the thread in it, then lead the thread into the notch in the fuselage and fasten it to the other end of the spar. Draw the thread tight enough to spring the spar forward slightly, thus keeps the tail surface taut.

Cover the underside of the tail with bamboo paper. Spread glue along the spar and thread, lay on the paper and press it down to assure its sticking. It is not necessary to turn the margin of the paper over the thread. Just trim off the margin, leaving only $\frac{1}{16}$ in. of it beyond the thread. Trim off the margin along the spar with a razor blade. Give the tail one coat of bamboo varnish.

THE rudder outline is made of $\frac{1}{16}$ by $\frac{1}{16}$ by 12 in. bamboo. Force one end into a hole drilled into the end grain of the fuselage and the other end into a hole drilled vertically through the fuselage $\frac{1}{16}$ in. from the tail end. The brace is $\frac{1}{16}$ by $\frac{1}{16}$ by $2\frac{1}{4}$ in. bamboo. Force it into place, cover both sides of the rudder with bamboo paper and give each side one coat of bamboo varnish. Trim off the margin with a razor blade.

The main wing is of the single-surface type. The spars are $\frac{1}{16}$ by $\frac{1}{16}$ by 24 in. white pine. The rear spar is bent at the center until the ends are 1 in. higher than the center; the front spar should be bent until the ends are $1\frac{1}{4}$ in. higher than the center.

White pine is bent in the same manner as bamboo, but should first be soaked with water at the point where the bend is to occur.

There are seven bamboo ribs $\frac{1}{16}$ by $\frac{1}{16}$ by 4 in. They are bent in a curve, the highest part of which is located one third the rib length from the leading edge. The center rib should be nearly flat, and the others bent up about $\frac{1}{16}$ in. The ribs are spaced $3\frac{1}{2}$ in. apart. Put a drop of glue on the spar and bind each rib in place with four wraps of silk thread each way.

The tips are $\frac{1}{16}$ by $\frac{1}{16}$ by 8 in. bamboo and extend 3 in. beyond the ends of the spars. They are bound to the inner edges of the spars with silk thread and glue.

After the wing is assembled, true it up and allow it to dry thoroughly. Cover the frame on top with bamboo paper and apply two coats of bamboo varnish.

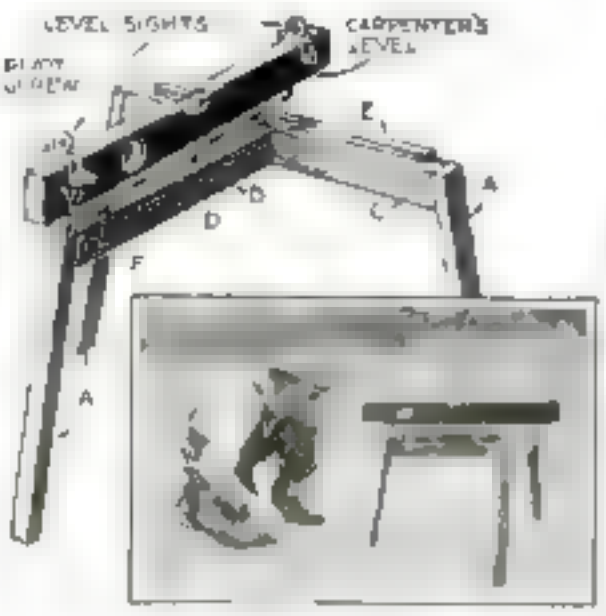
THE wing saddles are made of $\frac{1}{16}$ in. diameter piano wire. Start bending at the center of the wire, making two bends straight down $\frac{1}{16}$ in. apart. Go down $\frac{1}{16}$ in. and bend the wire up at such an angle that it will meet the wing spar $\frac{1}{16}$ in. from the center line. Here an offset or notch is made to fit the spar. The wire is then led across 4 in. and another spar offset is made. Bend the other end exactly the same way. Make two of these and map one into the front spar and the other onto the rear spar. These saddles must be accurately made, as they govern the wing adjustment.

The propeller is made from a block of soft white pine $\frac{1}{16}$ by $1\frac{1}{16}$ by 8 in. Draw the blade outline and cut the block to form a propeller blank. Drill a $\frac{1}{16}$-in. hole exactly in the center. Carve the back face of the propeller concave and the front face convex. The contour of the blade's cross section should be such that it resembles a wing curve. Sandpaper the propeller to a smooth finish and balance carefully so it will not vibrate when turning.

The propeller shaft is made of bicycle spoke $2\frac{1}{2}$ in. long. Turn a rubber hook at one end with a pair of pliers. Lead the shaft through the bearing and put on two washers of copper with $\frac{1}{16}$-in. holes. Force the propeller onto the shaft and then

(Continued on page 180)

Carpenter's Level Used for Sighting Long Lines



How the tripod stand is made and used for running foundation lines and similar work

IN SETTING foundation corners for small buildings and in grading, ditching and the like, I have found useful a simple tripod made as shown. It supports a carpenter's level equipped with sights of the type that can be obtained in the larger hardware stores.

To make the tripod the following parts are required: 3 legs A, 1 by 2 by 24 in.; 1 backbone B, 2 by 4 by 24 in.; 1 crosspiece C, 2 by 4 by 24 in.; 1 level rest D, 1 by 2 by 30 in., 1 filler piece E, 1 by 1 by 24 in., and 1 filler piece F, 1 by 2 by 2 in.—GEORGE W. BOYER.

IN MAKING small parts for models I have found useful old safety razor blades of the type having a stiff back. These are broken, chipped, ground and filed into various shapes to suit the need of the moment, the back being retained as a handle.—C. BALDWIN WHITE.

Simplest Flying Model

(Continued from page 128)

turn a tight loop on the end and force this loop into the wood at the propeller hub.

Give the fuselage skid and propeller two coats of bamboo varnish.

Loop on six strands of ¼ by ⅛ in. flat para rubber. Lead the rubber from the propeller shaft through the "cans," over the top of the wing to the rear hook. One may lubricate the propeller shaft bearing with a drop of oil or vaseline.

To fly the model, press the wing saddles onto the fuselage and loop a rubber band over the wing and under the fuselage. The leading edge of the wing will go about 11 in. from the propeller. Glide the model. If it glides heavily to the ground, move the wing forward. If it shoots up sharply and stalls, move the wing to the rear. Adjust the wing until the model makes an easy glide.

WIND the rubber clockwise until there is a row of knots its full length. Start the model above your head in level flight with the wind. The model may be turned to the left or right by forcing a slight bend in the rudder. After the model is correctly adjusted it may be wound its full number of turns, about 400.

This model will make beautiful long flights consistently and go up to a high altitude.

Plumbing Hints for Home Owners

Water Heating Coils

By Hugh Williams

BY FLUSHING out the water-heating coil in the fire pot of your house heating furnace or boiler and by keeping a duplicate coil always on hand so that it can be speedily installed in an emergency, you can forestall trouble with this part of your plumbing system.

There are several reasons why every householder should give careful consideration to this subject. For one thing, no coil will give satisfactory results during both mild and extremely cold weather. Its presence in the fire pot creates a dead spot directly below so that the coal at that spot is not entirely burned. Then too, coils will break, usually it seems, on Sunday, a holiday or at night, when it is almost impossible to get a plumber.

Coils are made in various shapes and in both iron and brass. The writer recommends one-piece bent pipe coils, which are the cheapest, interfere with the fire the least, and offer a smooth interior passage for the water. Brass pipes and fittings are, of course, to be preferred.

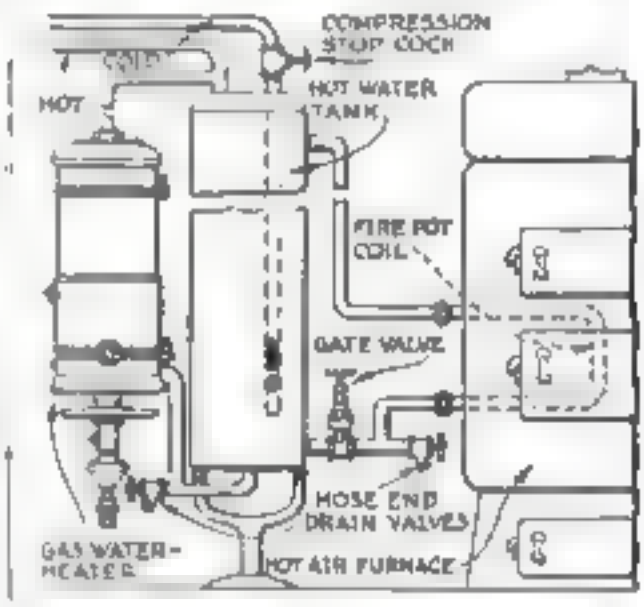


Diagram showing installation recommended by Mr. Williams. The vent on the gas water-heater must be connected to a chimney

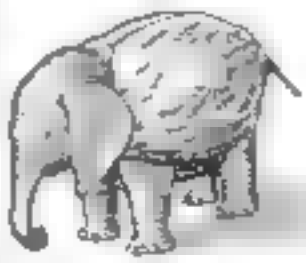
It is better to install a small coil that will deliver hot water in the coldest weather only. Use the gas water-heater during the fall and spring or on mild days during the winter. Furthermore, keep the coil away from the center of the fire.

Install a control valve, preferably a wheel-handled compression stop cock, on the cold water supply to the hot water tank. Then when the coil does break, the water can be turned off at this point.

Install a gate valve in the return pipe between the coil and the tank, with a wheel-handled hose-end drain valve in the line on the coil side of the gate valve. Use this frequently to flush out the lime, scale and sediment in the coil by closing the gate valve and opening the drain valve. A good idea is to attach a hose to this drain valve and wet the ashes in the ash pit before removing them. Be sure to close the gate valve to get best results in flushing the (Continued on page 131)

Walnut Shell Made into "Comicull" Elephant

By F. Clarke Hughes

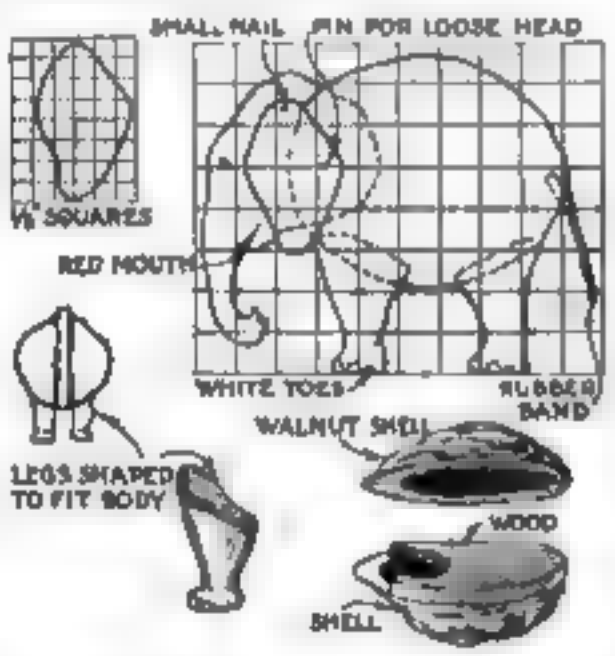


A novelty for use as a dinner favor or toy

A FEW odd bits of material, a few minutes of time, and a little patience are all that you need to make the little elephant shown as this month's "comicull."

First take a large walnut shell and a thin piece of wood that is a little larger than the walnut so that it may be marked and shaped to go between the two halves of the shell. Cut the wood to the shape shown and glue the two sides of the shell to it. Make the head of thin wood and cut out each leg separately to fit against the sides of the shell.

The ears may be made of bits of leather and glued or nailed to the head. Paint as realistically as possible.



How the elephant is made. The larger squares represent ½ in., the smaller ones, ⅛ in.

Water Heating Coils

coil, and then be careful to open the gate valve again to insure circulation from the coil to the tank. The flushing will prolong the life of the coil.

Under no circumstances should valves be installed on both coil connections, because the closing of these valves would create a steam chamber that would burst when the fire became intense and probably cause serious damage.

Get a duplicate coil and tie it to the beam right over the heating boiler. Then when one coil breaks, the plumber can install the duplicate, take the old one back to the shop, and at his convenience make another one, which can be attached to the beam ready for the next emergency.

In making small parts for models I have found useful old safety razor blades of the type having a stiff back. These are broken, chipped, ground and filed into various shapes to suit the need of the moment, the back being retained as a handle.—C. Baldwin White.

A Guide in Choosing a Radio Set

(Continued from page 71)

as well be operated on direct current from a storage battery, although they wouldn't be desirable for such use because of the heavy current required at comparatively low voltage

Then there are the heater type tubes, such as the 227 type, where the filament is used to heat a cathode or small hollow cylinder, and the latter supplies the stream of electrons to operate the tube. These tubes operate on raw alternating current stepped down to two and one half volts. They, too, could be operated with just as good results on direct current from a storage battery.

Another type of full electric set uses ordinary 201A tubes or 199 type tubes. The built-in B-eliminator in such sets is made large enough so that in addition to the B and C requirements of the receiver it will supply the necessary direct current for the A or filament circuit. The filaments of the tubes are connected in series.

The third system is to take a standard type of battery set and build into it an A-eliminator as well as a B-eliminator. Sets of this type are just as fully "electric" as any others, provided they require no attention beyond the occasional replacing of a tube. However, this method calls for more apparatus and the additional advantage may not compensate for the extra expense

Now as to the relative advantages of these various types of electric sets, it all depends on whether or not you buy high grade apparatus. Theoretically each system is capable of equally good results and the only question is, therefore, whether these results are obtained in the particular set you are thinking of buying. And the Popular Science Institute of Standards can help you decide that point

Radio apparatus, including electric sets, eliminators, A C tubes and all the most modern items are tested and their money value determined. Approval by the Institute means that the apparat is approved is worth the money. If, for instance, a particular electric set costing $150 appears on the approved list it means that the receiver is carefully constructed according to approved methods of reliable parts and will give good service. Naturally, it will not be as good as a $300 outfit. If it were, then the $300 outfit would not be worth what it cost and could not appear on the list

A Wireless Electric Light

AN EXTRAORDINARY new type of electric bulb without wires, developed by Dr. Phillips Thomas, research engineer of the Westinghouse Electric and Manufacturing Company, glows when held within range of a powerful electromagnet, and continues to glow for ten minutes after the power is shut off! Though you could turn it off, undress, and jump into bed by its light, it has no such immediate utilitarian purpose. It was developed by Dr Thomas in the course of experiments he is conducting on the transmission of power by radio

What We Owe to Newton

(Continued from page 35)

A trifling difference of less than three feet in the figures would not bother some theorists, but to Newton it was a great discrepancy, and caused him to abandon the research for the time.

Four years later Newton went back to the problem and found that he was right the first time and would be forever—if Einstein permits—right. Gravitation was established and the universe was safe. The cause of the early discrepancy in figures was an imperfect measure of the earth which gave a degree of latitude as being sixty miles. The corrected distance for a degree of latitude was 69.1 miles. The new calculation on the pull of earth upon her lunar friend worked out very closely and the law of the inverse square became a permanent part of human knowledge. This law rules in light as in the physics of gravity. It is in fact a self-evident truth.

THE best illustration of the inverse square is in light. One square foot of light at twice the distance from the source, or two feet, spreads to cover four square feet of surface. If the distance is again squared to four feet, the original square foot of light spreads to cover sixteen square feet. The original amount of light remains the same, and spreading, it reduces or thins it in the proportions given. In the last case a square foot has one sixteenth the intensity of the original amount of light.

Gravitation works on the same obvious principle, though invisibly. It is a magnetic force that spreads from the center of a sphere equally in all directions, increasing or diminishing according to the square of the distance from the central source. It is mutual between spheres. All matter partakes of it. Size or mass is a ruling factor.

Everything was grist to Newton's mathematical mill. While plumbing the depths of celestial space he analyzed the laws of chance that govern card playing for the benefit of his friend Pepys, man about-town and author of the well-known "Diary."

In Newton's time scientists had queer ideas on light and especially as to the origin of color. For example, red was supposed to be a condensed form of light, while blue was composed of black and white particles, as illustrated by the ocean mixture of black water and white salt. Instead of guessing in this way, Newton made a hole in a window shutter, let a ray of sunlight pass through the hole and then through a glass prism. Thus the white light was separated into the color elements of the spectrum from red to violet. The young experimenter measured all angles and distances, shifted his prism in every way, added more prisms and combed out by itself each band of spectrum color.

HE THEN announced to the world what is now taught to every school child: that white light is composed of rays of different wave lengths and that these rays, if separated, affect the eye as color—red for the short lengths and violet for the long lengths. Objects that we see as colored only seem so because they reflect a particular kind of ray and absorb the rest of the light.

Having found that the rays of white light do not focus together through a lens, Newton decided that the only efficient telescope must be on the reflecting or mirror principle. He built one on this principle that was a mere six inches in length, and yet it could magnify forty times, or as much as any refractor telescope a dozen times as long. With his tiny instrument the young man who was soon to become the master surveyor of the universe "saw . . . Jupiter distinctly round, with his four satellites, and also the horns or 'moonlike phase of Venus

(Continued on page 150)

What We Owe to Newton

(Continued from page 135)

As usual, scientific rivals tried to shake Newton loose from his optical discoveries. Had he not made a mistake with his prisms and angles? Newton was the bulldog breed. He had proved, he knew, and he never let go of any truth once in his grasp. The rivals growled and in due time backed away.

Like other geniuses, Newton had his blind spots. The first was alchemy and the second was a sort of fantastic theology. He wrote to a friend about to travel through Europe, asking him to "look into the very profitable science of turning base metals into gold."

To understand such apparently childish credulity it is well to recall that alchemy and chemistry were twins in Newton's day. Knowledge was in a pauper state. Furthermore, his fondness for alchemy did not alter by a hair's breadth the rigor of his mathematical research in pure and applied science. Again, the alchemist has almost regained respectability today. Transmutation of elements is now accepted theory. Some scientists declare they have turned mercury into gold.

WE MAY compare Newton, the alchemist, with Sir Oliver Lodge, the modern spiritist. Each is sound in science; each may be half right in his hobby.

Honors came to Newton steadily, from a professorship of mathematics at twenty-eight, to his becoming member of Parliament, a knight at the hands of the queen, president of the Royal Society and master of the royal mint. He took the latter job very seriously, devising improvements in coinage and ways of preventing counterfeiting. The custodian of the currency was annoyed when the world kept pestering him with questions on gravitation. He seemed to think that, after all, the royal mint was pretty important and gravitation was a topic to consider after business hours.

Newton never married. It is said that he kept a tender place in his heart for the girl playmate, Miss Storer, for whom he built doll furniture, and he provided for her financially in her latter years although she was twice married.

Toward the end of his long life of eighty-five years, Sir Isaac Newton said of himself with revealing and appealing modesty:

"If I saw farther, 'twas because I stood on giant shoulders."

HE MADE another statement yet greater that has deservedly become a classic, a thought of sublime humility and wisdom that man will never surpass and that may outvalue all his concrete achievements:

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me."

Trees Gage Wind Velocity

YOU can judge how fast the wind is blowing by trees' leaves and branches, says a French observer, who gives this table:

No appreciable wind, leaves still, up to two miles an hour. Light breeze barely noticeable, leaves feebly agitated, five miles. Moderate breeze, branches stirring slightly, ten miles. Branches bend a little, fifteen miles. Branches rocking and swinging, poplars bending, twenty miles.

Leaves torn from the trees, twenty-five miles. Tempest, light branches broken, thirty-five miles. Violent tempest, strong branches broken, fifty-five miles. Hurricane or tornado, damaging house roofs, in the neighborhood of eighty miles an hour.

Both Dad and Sonny Can Use This Buddy "L" Chest of Tools

35 Tools in This Big Chest

Vise, 16-inch saw, claw hammer, coping saw with blade, hand drill, 3 twist drills, 8-inch brace, 3 wood bits, spoke shave, 6-inch try-square, 3-inch screw driver, block plane, nail set, pliers, pencil compass, 2 tang butt chisels, 2-foot fold rule, marking gauge, carpenter's pencil, mounted oil stone, 6-inch file, wood miter box, apron, stamped wrench, 3 pkgs. nails, tang firm gauge, lock, wood cut-out set.

Four assortments from which to choose. Above is No. 4. No. 3 has 26 tools; No. 2, 23 tools, No. 1, 20 tools. All chests same size

Big, man-size tools packed in a rugged, iron-bound chest—not toys but real tools—big enough for Dad's repairing around the house—and just the right size so Sonny can build his own playthings for himself and friends.

And Buddy "L" FREE Blue Print Service shows him toys to make and how to build them—interesting, instructive, amazing, profitable.

You've always wanted a chest of best quality tools around the house. Here it is. Look at this picture. See the big, sturdy tools that never will wear out. Made by such manufacturers as Disston, Stanley, Greenlee Bros., Vaughan & Bushnell, Millers Falls and others just as famous—the kind of tools best carpenters use.

You just can't know what a wonderful chest of tools this is until you really use it. Write us. Send us your hardware dealer's name. We will give you prices, pictures and tell you about our FREE blue print service for building fun-making toys. Write TODAY!

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This seal on a radio, tool or all-human advertisement signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

If you want financial independence read the story "How a Big Load Was Lifted from Harry Wilson's Mind" on page four of this issue.

Where Did You Catch Cold?

Continued from page 28

to intense cold to see just what effects it would have. In the laboratory their necks were exposed to a gust of icy air—one of those drafts we have been taught to fear. This artificial earth wind was allowed to blow for some time, after which the victims were examined.

The examination revealed, for one thing, a set of sore throats. Furthermore, there was an apparent increase in the number of germs inhabiting the throats.

The experimenters concluded that one factor in the beneficial effects of cold bathing and outdoor living may be the training of the blood vessels to react to chilling by increasing the blood supply and so destroying germs—an example of the tendency of nature to cure its own ills.

When we hear of a cold wave, we think of snow and blizzards, yet the term literally describes the way colds affect the country. They do not confine themselves to one spot or even to one region. They cover the country.

SEVERAL investigations have been made to determine the extent of these epidemics and the time of their occurrence. One survey, recently made by the Federal Government, showed that, regardless of great differences in temperature, colds increased simultaneously all over the country, and decreased simultaneously.

The time of greatest prevalence was found to be January and February. The second worst time of the year was October, with the coming of cold weather; the third, early in spring. Some evidence tends to show that neither the incidence nor the severity of the disease has direct relation to climate, but that both are due rather to radical changes in dress and to other changing conditions in our mode of living which go with variations in the weather.

The Metropolitan Life Insurance Company has figured the effects of cold down almost to a degree of temperature. Using 6700 employees at its headquarters in New York as a basis of investigation, the company found that a drop of ten degrees in the weekly mean temperature meant an increase of eighteen colds in the group. Snow, rain, and humidity, however apparently had only a slight influence.

There are many kinds of treatments for colds. They range from common baking soda to inoculation, and from red flannel to carbolone, the deadly gas used in the World War.

Most doctors advise taking a laxative and sweating the cold out of the system by keeping warm and judiciously using hot drinks.

The inoculation treatment has been approved and disapproved. By means of two vaccines, one prepared from the bacteria in the throat and the other from animals, this treatment is intended to make the patient immune. Remarkable results, however, have been noted in some instances. In other cases, the treatment has had no perceptible effect.

Chlorine gas as a remedy is in pretty much the same status.

UNCERTAINTY regarding the true cause of colds has stimulated scientific research to a point where important discoveries are expected soon. Those engaged in the investigation include the Government, the Chemical Foundation, and the American Drug Manufacturers' Association. The American Telephone and Telegraph Company has undertaken an extensive survey of the disease among its employees. At numerous medical colleges experimental work has been long going on.

These activities indicate the tenacity with which science is clinging to the trail of one of man's worst enemies—an enemy that is invisible, and one whose identity is as yet but dimly discerned.

A Carpenter's Method for Spacing Work Quickly

ALMOST daily in my carpentry work I use a method for dividing large spaces into equal parts that is simple, speedy and foolproof. It is so rapid that I can say what the divisions will measure as quickly as I could measure the length that is to be divided up. This often surprises those who are looking on.

As an example, suppose a partition is to be put up across the end of a room to make a closet and is to be divided into three parts by studs (uprights), as shown below. We do not know just what the length of the partition will be, because we have not yet measured the width of

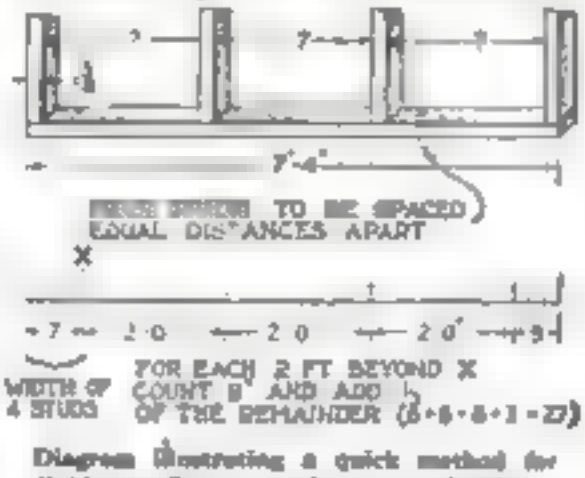

Diagram illustrating a quick method for dividing walls into equal spaces, as for panels

the room, but we do know that four studs will be necessary—always one more than the spaces (except in circular work).

First, we measure on the floor where the partition is to be placed a distance from the wall equal to the combined width of four studs, in this case four times 1½ in., or 7 in. Here a mark (X) is made. Next we lay our 2-ft. rule down, starting at this point, and say to ourselves not 24 in. but 8 in., or one third of 24, as we are to have three spaces. We lay the rule down again, measuring 2 ft. more but adding mentally 8 in. We do this again and add 8 in. more. In other words, we say 24 in. although our rule has actually covered 6 ft.

We find a space of 9 in. left over. This we divide by three and adding 3 in. to 24 get 27 as the distance at which to set the studs apart in order to divide the space into three equal parts. A study of the diagram will make this clear.

If four spaces had been wanted we should have used the same method but added 6 in. each time we set down the 2-ft. rule. For six spaces, we should have counted 4 in. for each move. For five spaces, it would have been necessary to take 20 in. on the rule each time instead of 24, and to count one fifth of that, or 4 in.—H. L. DERBY

WEAK compression springs can be made longer and often restored to usefulness by holding them on an anvil or some other solid surface and striking between the turns with a cross-peen hammer. The blows should be quick and rather hard. Pass along the spring to keep the tension even and turn it slowly as you work. If the spring is bowed, the same process may be applied to the concave side to straighten it. Gas engine valve springs can be put into excellent condition in this way.—SHERWOOD J. GEE.

When You Buy a Car—

[Continued from page 110]

hand," Gus went on, "the car you're fixing to buy, Ben, is not so good. It isn't much as a hill climber. It's sluggish on the pick-up. It needs overhauling perhaps a little more often than other cars in the same price class. And it needs quite a lot of servicing. Judged strictly on merits as a car, I'd say it was inferior to a number of others I could name.

"Humph!" muttered Ben. "Then I suppose you'll say I ought to follow Hank's advice, eh?"

Not at all, said Gus. "The quality of a car—any car—is only a part of the story—and sometimes a mighty small part at that.

"As a matter of fact you fellows could have saved yourselves the trip down here. You're both right! Each of you has picked out the car that I would have recommended.

"I don't see how that can be," argued Hank. "You've practically told Ben he's picked a lemon and yet you tell him to buy it. What's the big idea?"

"Well," said Gus, "the point is, I know you two birds. You're a bug on machinery, Hank. You'd take care of a car so well there wouldn't be a chance for any real trouble, and if you do have a breakdown you'll fix it yourself. Chances are after you've once bought your car you'll never go near the dealer again.

"NOW, Ben, you're a lawyer. You don't give a whang-doodle about anything mechanical. You don't know what goes on under the hood of a car and you probably don't care. All you want is a good-looking bus that will stay on the job and get you from place to place without worry.

"But why shouldn't I take Hank's advice?" questioned Ben.

"Two good reasons, Ben," Gus replied. "The dealer who handles the car Hank favors is, as I happen to know, a slick article. He'll stick you for a wad of money every time you poke your nose in his door looking for a little service. That doesn't make the slightest difference to Hank, because he'll never have occasion to go near him. The second reason is that the dealer who handles the car you've picked out would sooner go out of business than take advantage of anybody. Maybe his car isn't quite so good, but he'll keep it on the job for you and that's what counts!

"When you're buying a car," Gus summed up, "don't let a high trade-in offer stampede you into buying a car you really don't want. Pick your car solely on the basis of mechanical merit if you expect to do all the work on it yourself, but if you expect to let somebody else do the work for you, choose the car that is represented by a dealer who is able and willing to give you honest service."

New Gains in War on Disease

Figures, not speculation, are the basis for recent statements that progress of the war against disease is more hopeful than ever before.

John K. Gore, Vice President and Actuary of the Prudential Insurance Company, finds that in the last quarter century science has saved 635,000 lives each year, and has prolonged life in thirty-two countries.

The Surgeon General of the United States, Dr Hugh S. Cumming, recently reported that during the year ended June 30, 1927, there was a general decrease in the number of communicable diseases, and that America was free from epidemics and plagues. Research work for control of cancer, goiter, influenza, leprosy and malaria especially has shown encouraging results.

The fight against cancer was focused in a nation-wide campaign of education, with the cooperation of physicians and hospitals. Doctors say that this dread disease, which stands third as a cause of death in America, can be conquered if caught in its early stages.

Is Lost Explorer Now Jungle God?

(Continued from page 11)

the lower reaches of the Xingu in a dugout, his little party might at any moment have been wiped out by a storm of poisoned arrows from the bows of ambushed Campos or Cayabes.

But pulled off to the eastward they would have run into no such serious peril. They should have emerged many months since either on the Atlantic Coast at Bahia or at the mouth of the Amazon after a comparatively easy trip down the Araguaya.

Then what mishap has delayed them?

Let's reconstruct their subsequent adventures. Chopping their way painfully a few miles a day, through vine-tangled jungles where even at noon the light is dim, they encounter no dangerous animals. Even a jaguar will not attack mules wounded and cornered.

BANDS of chattering monkeys pursue them overhead; gorgeous birds and butterflies flicker through the trees. Wild life all around them, but none of it is dangerous.

Hunger is needless, there is game on every hand. Malaria is not fatal. A novice might get lost. Col. Fawcett is equipped with compass and mapping paraphernalia and familiar with every trick of "jungle navigation."

So there remain only the Indians to be reckoned with.

But these wild children of the jungle are less dangerous than the semi-civilized tribes whose haunts Col. Fawcett has long since passed. As the Fawcett party proceeds naked warriors slink through the ferns to watch with childish curiosity these strange creatures. But the party plods methodically ahead and makes no offensive actions, and the Indians leave them alone. Fawcett is too wise in Indian psychology even to unsling his camera. A camera pointed at them will frighten them into hell-for-leather. But if a monkey is shot for lunch, the sound scatters the trailing Indians in abject terror.

But as Fawcett penetrates farther into the jungles north of the River of Death his transport problem becomes inevitably more difficult. His mules are gradually perishing from hunger or disease. He awakes one morning to find that vampire bats have sucked so much blood from one animal that it must be killed. Later a pair of pack mules becomes hopelessly mired in a swamp. Fording a swift river, another is carried away and drowned. Descending a steep mud bank, one falls and breaks a leg. And when the pack train has dwindled to two or three, Fawcett's party, unable to continue, stops at an Indian village for native helpers.

AND here arises the disastrous mistake in Fawcett's plans. He announced before he left that when he came to dealings with the Indians he would play upon their superstitions to persuade them that he and his companions were supernatural creatures endowed with magic power. While among them he has used his rifle, surveying instruments, matches, compass and flashlights to arouse their fascinated superstitions.

And then one day he and his companions awake to their wigwam to find that all their supplies have been stolen. They are helpless. Their Indian hosts have become so impressed by the magic power of these white gods that they have taken steps to keep them permanently in the village. Thus the whole tribe will share in the magic, become all powerful in war and the chase, and be freed from the terrors of Nature, like thunder and lightning.

It is the historic hobby of these Brazilian Indians to make such prisoners. From the days of the early explorers, João Ramalho and Diogo Alvares, down to the year 1927, the instances of whites in captivity throughout this country are frequent. Recent cases are cited by the Brazilian (Continued on page 140)

Is Lost Explorer Now Jungle God?

(Continued from page 139)

ethnologist, E. Roquette-Pinto. Last summer I heard of cases near Juruena. The Indians' fondness for strange human beings, whether white or negro, resembles a child's affection for a toy. They cling to them and make tribal divinities of them.

Col. Fawcett sits presumably today in the door of a crude wigwam. Other wigwams are dotted about. Indian women crouch over the fires, roasting tapirs and monkeys; the men are off hunting, or practicing archery with hornets' nests for targets. The Colonel and his companions are under the ceaseless surveillance of a band of girls.

And what can the white men do? Try a violent escape? They can no more get out of that wilderness, once the Indians' animosity is aroused, than a cornered mouse can escape a cat. Col. Fawcett, knowing this all too well, can only wait patiently, hope for rescue, and continue to play his role of minor divinity.

He, with Jack Fawcett and Raleigh Rimmell, have become a pagan tribal trinity, and as such they are safe, well cared for, worshipped with weird rites and fed on outlandish dainties like iguana eggs and roasted ants and caterpillars. At night they watch the ceremonial dances, in which naked warriors, painted red and black and wearing gaudy feather headdresses, shuffle about the fires with a monotonous guttural chant.

I could describe their daily life in detail, for I was for a short time a similar captive-guest among the Carajas, on the Island of Bananal. The Araguaya River flowed by the village, and offered escape to the Amazon. In the wilderness north of the River of Death, Col. Fawcett has no such opportunity.

BUT now let's look ahead a few months. One morning as Col. Fawcett wanders about the village, he notices suddenly an alert restlessness among the Indians. Their wonderfully sensitive ears have caught a distant drone, faint but increasing, which in another moment he himself hears. The naked brown bodies become rigid; the black eyes probe apprehensively the jungle foliage. The drone becomes an appalling roar. The Indians perceive a monstrous white bird swooping low over the tree tops and singing a terrible song.

Instantly, with cries of abject horror, the entire population of the village flees into the fastnesses of the jungle. Fawcett and his companions, left unguarded, rush to a clearing, in a wild demonstration to catch the eye of the circling airman. Or if there is no clearing, they raise smoke signals through the foliage. Commander Dyott's airplane has found them.

This is the only solution that I see to the mystery of Col. Fawcett's disappearance. It has been part of Commander Dyott's project from the start to use an airplane in his relief expedition. An overland party cannot pick up the trail; even Fawcett's camp sites will have been obliterated.

The scouting airman can detect the location of Indian villages—and they are not numerous—by definite signs. The wigwams will be obscured by foliage, but there will be a near-by clearing, a few dugout canoes and the smoke of fires rising through the foliage.

Spotting his villages, the airman will circle over them as I have suggested, and from one or another at last he will receive the signs that reveal Col. Fawcett's presence. The ground party, notified by radio or, if that is wanting, by the return of the plane, will push through to the village. And when it reaches the scene of Col. Fawcett's imprisonment, the plane will arrive again, sending the savages once more far into the jungle. And I can imagine Dyott striding up and paraphrasing Stanley's words.

"Col. Fawcett, I presume?"

Triumphs of Radio's "Hams"

(Continued from page 40)

Tonight? See you later—best regards"

"Wouff hongs" annoyed the early operators. On the authority of the League, the name wouff hong is a typically garbled, unintelligible phrase from an inexpert dot and dash operator, and its real significance is the local interference that has all but disappeared with the abolition, except for emergency, of the old-fashioned, sputtering spark set. "Hams" conceived the wouff hong as a mythical, air-lurking beast whose statuelike growls disrupted transmission.

At last, in 1923, an American amateur, 1BCG, of Greenwich, Conn., transmitted the first amateur trans-Atlantic message, and ten other amateurs were also heard by eight British "hams"—all this with extremely low power—less than a kilowatt—and with grasshopper-wired antennas.

For the first time in history, on the evening of November 27, 1924, two amateurs on opposite sides of the Atlantic were talking with each other. Station 1MO, in West Hartford, Conn., heard a radio flash from Leon Deloy at station 8AB, in Nice, France. He replied and for two hours they conversed. Now the international amateurs use conventional signals, such as "QRK," meaning, "I am receiving well," while they brush up on their foreign languages.

IN 1925 Hiram Percy Maxim, noted inventor and President of the American Radio Relay League, went to France and suggested formation of the International Amateur Radio Union, which elected him its president. In November of that year the first international amateur call list was published.

Now new tests commenced. The amateurs had been relegated to what commercial companies considered waves of no value, such as those below two hundred meters. But these low waves in the amateurs' skillful hands proved the most efficient of all for long distance. The "hams" soon were able to use as short wave lengths as twenty to forty meters to talk around the world!

This was the stage setting when the International Radio Telegraphic Conference met recently in Washington, D. C., to settle all the new problems, and, incidentally, to decide the fate of amateurs. America knew the value of amateur radio, and the United States was the amateurs' friend. Secretary of Commerce Hoover commended them. Canada, Australia, and South Africa, where amateurs were powerful, were friendly. But broadcasting stations of other countries were greedy for the very waves the amateurs had developed.

THE Conference's recent decision is an amazing, unprecedented endorsement of the amateur. Now the radio amateur has international status and recognition. Radio "hams" the world over have the exclusive use of two of the most useful low wave bands, stripe at their regular wave lengths of twenty and forty meters—which are forbidden to commercial and even to Government stations! Besides receiving the right to share two wide bands used largely for radio phones instead of dot-and-dash transmitters, amateurs are given, too, the free use of all waves below thirteen meters.

In this dark, unexplored region of radio they hope to make new advances as striking as those of the past. Already their international tests are under way with waves as short as five meters!

Through a countrywide investigation POPULAR SCIENCE MONTHLY is now able to present first-hand information upon the real status of amateur aviation. Read next month the facts disclosed by the first authoritative survey of the airplane's practical use as any man's business or pleasure vehicle.

A definite program for getting ahead financially will be found on page four of this issue.

He Rebuilt His House and Saved $6000

(Continued from page 141)

two and a quarter inches wide, the usual random lengths. Of course I put on the oak at right angles to the old boards. As to thickness, I used seven-eighths-inch downstairs and half-inch upstairs. The thinner stuff upstairs was not to save money but to avoid too much pounding lest it damage the plaster ceilings below. Oak is tough and takes some hammering.

"I guess you used the regular flooring nail?"

"No. I got square-cut galvanized nails—eightpenny for downstairs and fourpenny for up. Square nails are more difficult to handle and to avoid splitting the wood, but they hold better. After the floors were laid, I scraped them by hand, put on two coats of shellac and finished with wax. Incidentally, I saved about two cents a square foot on my oak by buying it in winter when the lumber trade is slack and prices are lower. This saving paid for the material in one room.

"HOW about that old plaster you were afraid to jar?"

"Oh, that lime plaster is more solid than you'd think. It hangs together because of the hair it contains and it is about twice as thick as a good deal of modern plaster. It runs to an inch and a half. It will stay for another generation or two.

"The roofing is asphalt shingle over two-ply asphalt roll roofing with sheathing boards underneath.

"I took out the old warm air furnace and put in a steam boiler with a single pipe return system. It serves both families. A water heating device is connected with it.

"We have two electric voltages, 220 and 110. The former is metered separately for electric stoves—each family has one—and for other power uses, like a washing machine. You know there is a special low rate for a power line. The lower voltage takes care of the lighting and has its own meter. All electric and heating bills are divided.

"To bring water to the house from a main 800 feet distant, the water company asked a dollar a foot for digging trench and about the same for two-inch pipe. (The extra size of pipe allows for distance and for future contingencies.) The owner decided that a little pick-and-shovel work would be agreeable and credited himself with a saving of $400. He bought galvanized pipe and connected it himself. It cost less than $500. The total saving was $900. However, it must be said that the water company pipe, being a new alloy cast iron, is a superior material.

A TWO-CAR garage with cement floor and with steam heat, light and water obtained from the house, completed the improvements. A builder estimated the garage to cost $720. The owner did it himself for $120, partly by using surplus material that had been lying around.

"Some day," I said, "there may be an argument over the coal and electric bills."

Joseph Penka laughed. "I expected that one. The steam pipes are laid out so that, on short notice, I could put in another boiler and let the other family do what they pleased. It is the same with the electrical wiring. I can have separate meters installed."

Perfumed Anesthetic Is Latest

ETHER masks scented with perfume are the latest surgical novelty, according to Dr. Gohrbrandt, German physician. The nauseating smell of the anesthetic is said to be eliminated, and the patients go quietly to sleep in comfort.

Women, particularly blondes, are as a rule much better at receiving anesthesia than men, declares an American dental expert.

Romance Jams the Log Jams

(Continued from page 85)

lumberjack for camp—were neither so tough nor so heroic as the lumberjacks of fiction. River driving is a business, not a melodrama. It's a colorful and often an exciting business, but it's a business built on these three solid facts: Water will run downhill. Logs will float. With anything like decent water conditions, logs can be driven from the woods to the mills a lot cheaper than any railroad could carry them.

The business men at mahogany desks in steam-heated offices in Montreal and Portland and New York who pull the strings that send millions of logs rushing down northern rivers on the freshets of May and June do not think log driving is a declining business. Each year the woods crews must go deeper into the back country for their logs, so the tendency is toward longer drives and more efficient drives—drives that move faster and leave fewer logs stranded. Each year many thousands of dollars are spent improving the rivers that carry their drives: blasting away troublesome boulders, and building heavy crib work to keep the logs running free in the channels.

BUT about these dollar-and-cents details the lumberjack refuses to fret his carefree soul. He toils and eats his beans with a mighty appetite, and when the drive is down spends his pay in the time-honored fashion of his kind.

Conditions vary with localities, but in New England and eastern Canada the cutting crews fell trees from September until spring.

When winter snow makes what old Joe calls "good slippin'" for sled runners, teams haul great loads of the logs to the frozen streams. Some are "landed" on the ice; more are piled in great "rollways" on the steep banks. When spring comes the break-up of the ice carries out the "landed" logs. Breaking out the rollways is a dangerous and spectacular performance that demands a clear head, quick wits, and agile body. Many a lumberjack has died in an unexpected cascade of logs.

"I mind one," said old Joe, "I was pokin' away at the key log of a rollway and she wouldn't budge. I got mad and hooked my peavy into that old log and pulled for all I was worth. But she came and the whole kit and kaboodle of logs came down on top of me. Get hurt? Not me! Not a one of them techted me. While the boys were lookin' for my remains down on the bank, I climbed up and hollered to them. Most surprised bunch ever I seen."

Most interesting is the Androscoggin River drive that starts in the Rangeley Lakes district of Maine and ends at the mills of Berlin, New Hampshire. It isn't long as drives go, but in its fifty-odd miles it includes almost every variety of log driving.

THE bulk of the logs handled on this drive are cut on the shores of Lower Richardson Lake, southernmost of the beautiful Rangeley chain of lakes. These logs are chained into great rafts and towed down the lake into Rapid River. Old Joe took me to see the logs sluiced through the dam into the river. The blue water of the lake was carpeted for the space of several city blocks with bobbing logs confined and controlled by long booms of logs chained end to end. Over the shifting floor lumberjacks gay with bright checked shirts skipped nimbly, the calks—half-inch steel spikes—of their driving boots giving them momentary footholds. On the dam other lumberjacks, armed with pickpoles, waited.

Then the sluice-gate was raised, and the lake water a good seven feet above its normal level, rushed through the narrow opening and leaped roaring twenty feet down to the rocky bed of Rapid River. On this water rode the vanguard of the drive—four-foot pulp logs that were carried down like (Continued on page 144)

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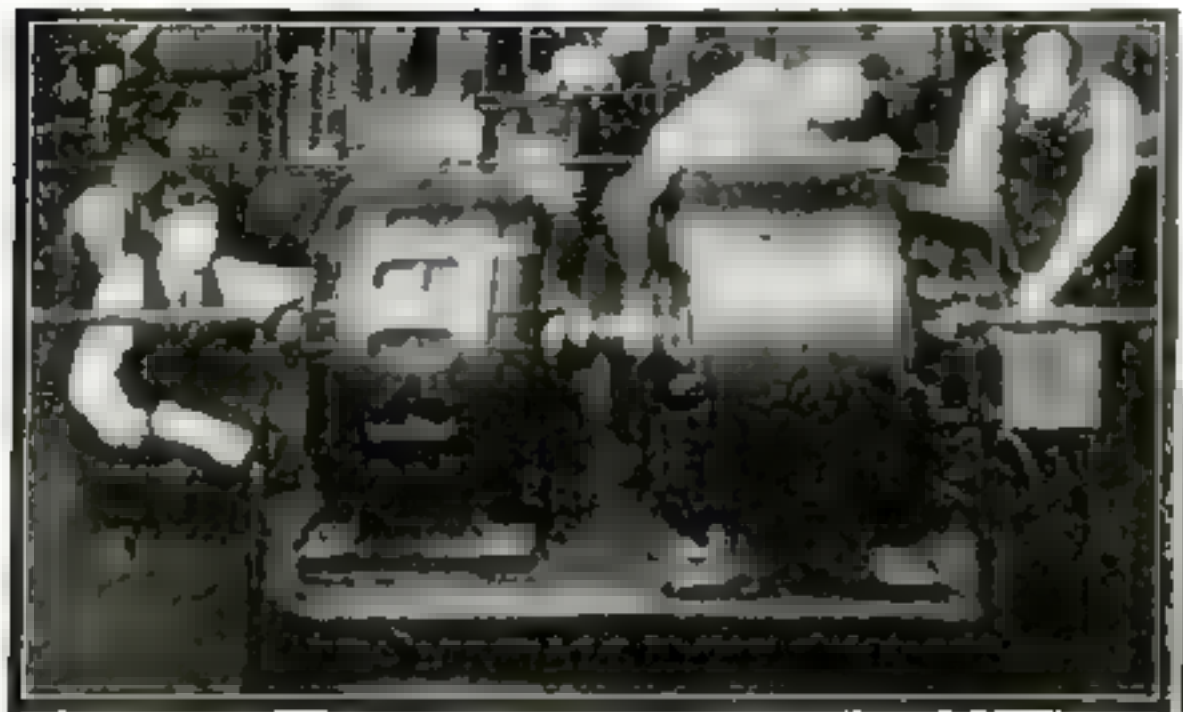

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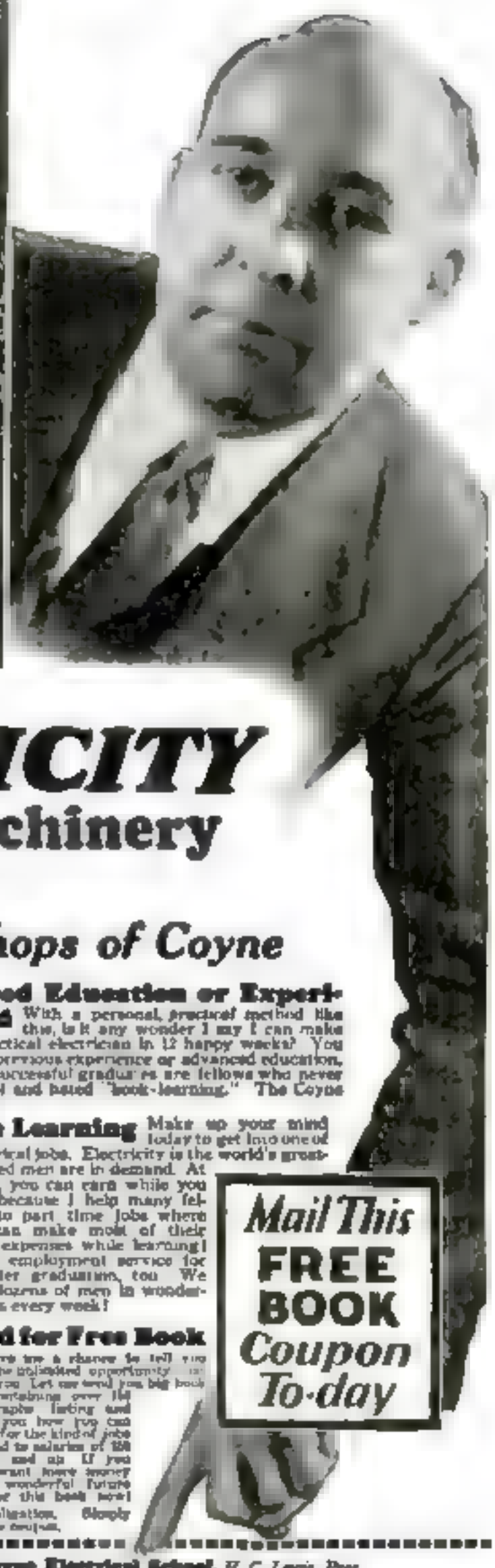

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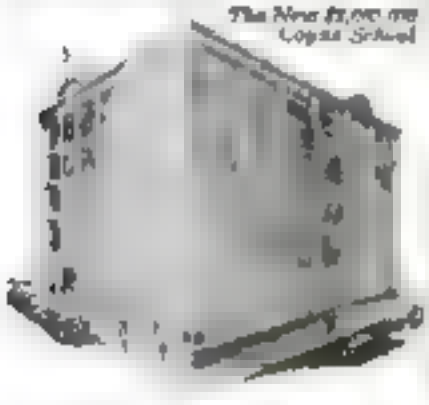

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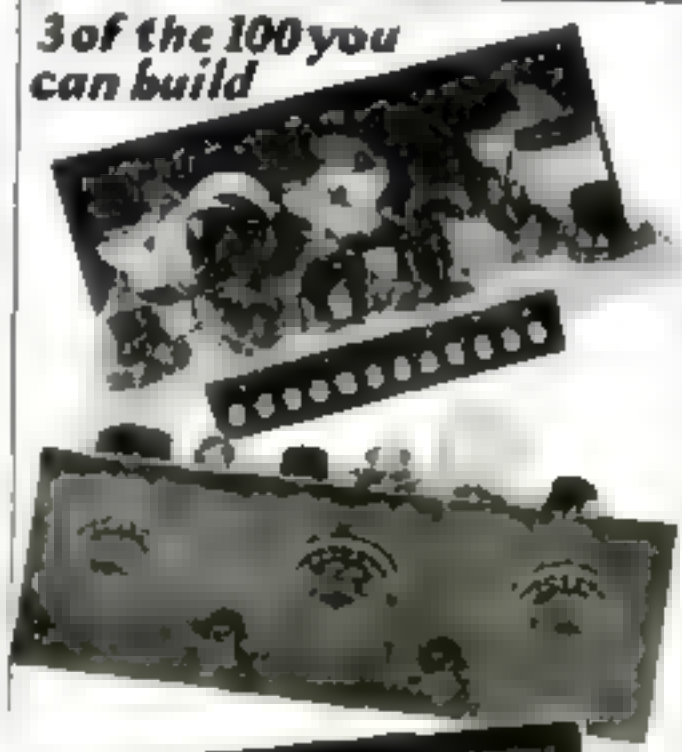

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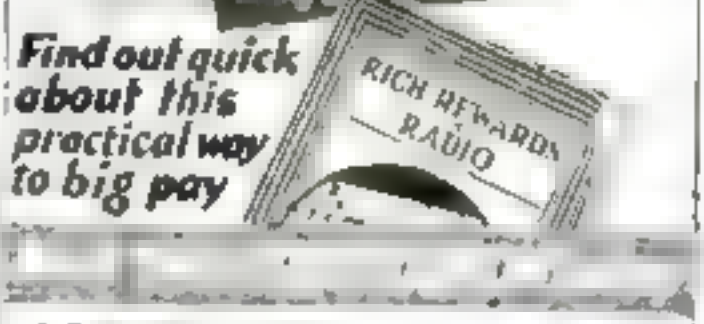

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Laboratory and Chemical Services

[illegible] chemical problem solved and exact formula or process furnished for $5.00. Write [illegible] Laboratory, [illegible]

[illegible] chemical [illegible] Reports [illegible] Laboratory, [illegible]

Lathes

[illegible] Lathe [illegible] complete. Foot swing, 3 speed [illegible] Jefferson, Fairfield, Iowa.

Letter Specialists

[illegible] Circular Service, 115 Pleasant St., New Bedford, Mass.

Machines

SECRETS Building Block machines and Molds. Catalogue free. Concrete Manufacturing Co., St. Louis, Mo.

Magic Tricks

[illegible] A magician, give shows, earn money. Catalogue 20c. Chas. Nielsen Co., Dept. 350, Wabash, Ind.

CARD tricks, Coin tricks, [illegible] novelties, [illegible] books. 10c each. H. Fender, 240, Jefferson, Louisville, Ky.

Miscellaneous

[illegible] Learn Lead Soldiers, Indians, Uniforms, Trappers, Animals, Civilians. Send for Illustrated Catalogue. Lucas Heath, Schenectady, 1034, 3rd St., Brooklyn, N. Y.

SELL [illegible] Ask today for a copy of the Quick Action Advertising Rate Builder. It contains some really important facts which all prospective users should know before placing orders. Has Your Ad Pulling Power Increased Profitably? You'd like to know. Address your nearest office of Standard Advertising Register, Chicago, Detroit, Atlanta, Kansas City, Dallas, Seattle, Los Angeles, San Francisco, New York.

[illegible] Shoes [illegible] Wanted for Women. Make [illegible] Write Quick. Dept. 4, [illegible]

[illegible] Ideas Wanted, Talmagram, Post Building, Washington, D. C.

Kodak [illegible] Prints and Enlargements. Send for price list and [illegible] Rochester Photo Finishing Co., Rochester, N. Y.

Models and Model Supplies

[illegible] Models of parts [illegible] Tools. Metal Specialties. Model [illegible] Write for catalogue. The Perfect Model Works, Perfect Bldg., [illegible]

Wanted Models. Send Ideas and Sketches. Fred Wolf Co., [illegible] New York.

[illegible] Model Builders' Sterling Wheels, Cogwheels, Armatures, Propeller Hubs, Steel Rings for brackets. Ask [illegible] Work Co., Fond du Lac, Wisc.

[illegible] Send [illegible] catalog [illegible] for ship models [illegible] Model Builders' Supply Co., [illegible] Complete outfits, supplies, [illegible] Send for catalog. The Ideal Model Co., 3-31 Douglas Ave., Portland, Ore.

[illegible] Supplies Catalog [illegible] Expert [illegible] Rogue River, [illegible]

[illegible] Model [illegible] Building Special Machines [illegible] Write [illegible] Model Engineering Co., 1133 Broadway, New York.

Moving Picture Business

[illegible] Opportunity! Big [illegible] with [illegible] Capital [illegible] Complete [illegible] Write Atlas Moving Picture Co., [illegible] Michigan Ave., Chicago, Ill.

Music and Musical Instruments

SONGS [illegible] Publication [illegible] Free Booklet. Write Us Today. Richard Brothers, 1674 Broadway, New York.

[illegible] Music for Amateur Teacher or Musical. Catalog free. Dent Zarb, Publisher, 1133 Broadway, New York.

PIANO JAZZ. Teacher Wants Partner. Has Mailing Plan. All the Chicago Jazz Novel Harmony Books using Interesting Information Free. Write Have Bill, 20 Bellevue, Toronto, Can.

Novelties and Pictures

ARTS [illegible] 300 All Different Postcards for Boys & Adults (Captain) Dept. 3, [illegible]

Paint Like Marble

MARBLEITE [illegible] Paints capable with highest [illegible] when [illegible] Interesting Free Prospectus. Write Rockford Varnish Co., Rockford, Ill.

Patents

[illegible] Incorporated, Lawyers, 70 Patents [illegible] Trade and Foreign Business carefully conducted.

SECRET SERVICE. Write today for a copy of the Patent Record and Inventor's Guide. It's a mine of valuable information and is yours free upon request. Write Victor J. Evans & Co., 759 Ninth, Washington, D. C.

Patent Attorneys

PATENTS. Time counts in protecting your ideas. Don't delay. Send sketch or model for search and instructions. Terms reasonable. Highest references. Write for Record of Invention Blank and Booklet, How to Obtain a Patent and Selling Aids, sent free. No charge for inquiries and preliminary advice. Prompt, careful, personal service. Clarence A. O'Brien, Registered Patent Attorney, Security Bank Building, directly across street from Patent Office, Washington, D. C.

PATENTS. Booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C.

PATENTS. Ideas can be sold. Let us tell you how and help you make the sale. Free particulars on request. Write W. T. Greene, 321 Jenifer Building, Washington, D. C.

E. G. BAKER, Patent Lawyer, Washington. Loan & Trust Building, Washington, D. C.

PATENT trade-mark and right. Reasonable and by an experienced patent man, detailing personal attention in each case. Inquiries invited. References furnished. P. P. Philburn, Patent Lawyer, 526-C Merrill Building, Washington, D. C.

PATENTS. WATSON E. COLEMAN, 624 F Street Building, Washington, D. C. Originators of the Form 1 Manner of Application. Before disclosing your invention to anyone send for blank. Terms to be agreed and returned. Form and opinion [illegible] booklet free.

PATENTS. Time and [illegible] protect your [illegible] registered by owner. Report Patent Office Practice. Booklet. Albert Jacobs, 728 Barringer Bldg., Washington.

Patent Attorneys

ADAMS [illegible] Registered Patent Attorneys, 69 Southern [illegible] 25 years' experience. [illegible] and prompt [illegible] Dept. [illegible] Washington, D. C.

PATENTS secured. Free [illegible] Inventors' Aid [illegible] Bureau, Box 646, Washington.

INVENTORS [illegible] Write [illegible] Kidder & Kidder, [illegible] Patent Lawyers, [illegible] Washington, D. C.

PATENTS. Send [illegible] Invention [illegible] Free report [illegible] Highest references. Prompt [illegible] Write [illegible] Send our [illegible] for [illegible] and [illegible] Write [illegible] Hyman & Berman, 212-A Victor [illegible] Washington, D. C.

PATENTS. Free [illegible] Highest [illegible] Reasonable [illegible] Write [illegible] Richard B. Owen, 69 Owen Building, Washington, D. C.

PATENTS [illegible] Write [illegible] Patent Office [illegible] Books [illegible] Free. Highest [illegible] Best [illegible] Write [illegible] Victor J. Evans & Co., 759 Ninth, Washington, D. C.

[illegible] Patent [illegible] Write [illegible] Patent Office [illegible] Books [illegible] Free. Highest [illegible] Best [illegible] Write [illegible] Victor J. Evans & Co., 759 Ninth, Washington, D. C.

Patents for Sale

[illegible] Will [illegible] exclusive use for [illegible] Adam Hyatt Mfg. Co., [illegible] Mo.

[illegible] Patent [illegible] Write [illegible] Patent Office [illegible] Building, Washington, D. C.

Photographs and Supplies

[illegible] Photographers! Write for free sample of our big [illegible] Better [illegible] Photographs, 417 Custom House, Boston 10, Massachusetts.

Make [illegible] Photos of Parties, Weddings, Babies, Pets, Outdoor Scenes. Nothing like it. Experience unnecessary. Specialist School of Photography, Dept. 1741, 3601 Michigan Ave., Chicago.

Photoplays Wanted

$125.00 [illegible] Stories, plays, [illegible] unknown writer sold through our [illegible] Submit [illegible] Free copyright and booklet. Located in the heart of Motion Picture Industry. We know [illegible] Universal Scenario Corp., [illegible] Woodward Building, Washington, D. C.

Post Card Views

[illegible] Photo [illegible] Postcards [illegible] Any [illegible] Size [illegible] Send [illegible] Write [illegible] Dept. [illegible]

Printing and Engraving

[illegible] Printing for Less Money. Write for [illegible] Printed [illegible] Write [illegible] Printing, Box 1, [illegible]

[illegible] Advertising Novelties. Rubber [illegible] Catalog free. Ideal Products Co., 1133 Broadway, New York.

Make [illegible] Printing [illegible] Write [illegible] Printing Machinery Co., [illegible] Ohio.

[illegible] Printing [illegible] Samples [illegible] Write [illegible] Printing Co., [illegible] Ohio.

[illegible] Printing [illegible] Samples [illegible] Write [illegible] Printing Co., [illegible] Ohio.

Printing Outfits and Supplies

PRINT your own cards, stationery, circulars, paper, etc. Complete outfit, $6.85. Job Printer $1. Size Rotary $14. Print for others, big profit. Alluring rubber type. Write for catalog, presses, paper, etc. Kelsey Company, F-3, Meriden, Conn.

Rabbits

MAKE big profits with Chinchilla Rabbits. Real Money Makers. Write for facts. Colorado's Best Chinchilla Ranch, Denver, Colorado.

Radio

BECOME A BROADCASTER. We furnish John No five Brochure now on our list of prospective broadcasters. Inquiries from your locality will be returned at once. We are headquarters for parts for Hammarlund-Roberts, All or Shielded Six, Karas Equiphase Power Tally Power Six, Hartman Counterbalance and other popular circuits. Register at once. Give references and experience. Allen-Rogers-Madison, Inc., Dept. 42, 33 West 31st Street, New York, N. Y.

Real Estate—Orchards—Farm Lands

PECAN Orchard Pig Grown "On the Gulf" Monthly payments. Guaranteed care of quick returns. Splendid Orchards, Dept. "R," Pilot, Miss.

OZARKS Be among first. Will [illegible] and proposed power dam sites, $5 monthly. Al a Zimmerman, 1003 N 5th, Kansas City, Kans.

Salesmen and Agents Wanted

AGENTS Clever invention! Sharpens a razor in every pen a fountain pen. Fast office seller in retail stores and specialties everywhere. Exclusive territory offered. Sample free. H. Marsh, Masonic Temple, New York.

[illegible] free sample offer, plan of [illegible] and specialties. Profits all year. La Derma Co., Dept. F, [illegible] Michigan.

AGENTS $60 to $200 a week. Genuine gold letters for store windows. Easily applied. Free samples. Liberal offer to general agents. Metallic Letter Co., 414 N. Clark, Chicago.

$10 A Y will bring [illegible] and astounding [illegible] Auto, [illegible] Outfit furnished. Write Universal Co., Ave. F, Decatur, Illinois.

AGENTS Take orders and Rubber Heels for Fords and Cubes. Sensational [illegible] at a saving of over 400 per cent. Just [illegible] and slip on in two minutes, and is guaranteed to last the life of the tire or tube with a very slight wear and necessary dealer to get quick action now. Make big money and free sample offer. Arrow Auto Rubber Co., 304 Arrow Building, Philadelphia, Pennsylvania.

AGENTS Sell your own Making Sparkling Glass Name and Number Plates, Checkerboards, Signs, Big Book and Sample free. E. Palmer, 519, Wooster, Ohio.

AGENTS Take a dollar an hour. Sell Members a patent patch for instantly mending leaks in all utensils. Sample package free. Collette Mfg. Co., Dept. 407, Amsterdam, N. Y.

EARN $10 daily silvering mirrors, plating and refinishing metal ware, headlights, chandeliers. Instructions Outfits furnished. Wonder Laboratories, 226 Varick Street, New York.

IS PROFITEER [illegible] advertising? Are you declining profit from your advertising? Write today for a copy of the "Quick Action Advertising Data Folder" showing How You Can Be a Popular Release Monthly Profitable Address your inquiry to Manager, Classified Advertising, Popular Release Monthly, 280 Fourth Ave., New York.

CALIFORNIA perfumed beads selling like hot cakes. Agents making money. Big profits. Catalog free. Mission Factory, 11 3526 W. 61st, Los Angeles, Calif.

AGENTS Remarkable priced Auto Emblems for every Lodge. Sells for only $1.25. We furnish [illegible] selling preparation and [illegible] Sample case offer. North Central Emblem Co., Department 13, Aeolian, Ohio.

$100 to $300 New Patented Apron. No scrubs or straps. $30 to a day every day after 10 to profit every minute you work. Write for free offer. Ko-Rub Co., Dept. 90-K, St. Louis, Mo.

LAY [illegible] Wood pulpwood, [illegible], Newhall, [illegible], Tyler, Texas.

AGENTS $12 and Hammacher sales $50 to $100 daily. We start you, furnishing everything. Distributors, Dept. 24, 616 W. Superior, Chicago.

[illegible] Your own Products. Make them yourself. Formulas, Processes, [illegible]. Alfonso Catalog, directions free. C. Healy Co., Washington, D.

AGENTS We start you in business and help you succeed. No capital or experience needed. Spare or full time. You can earn $50 to $100 weekly. Write Madison Company, 566 Broadway, New York.

AGENTS ATTENTION! Ask today for a copy of the "Quick Action Advertising Data Folder." Containing many really important facts which will prove interesting and valuable to you. Address: Dept. Y, Popular Release Monthly, Pulpwood, Ohio. Would like to know whether you Advertising Manager, Classified Advertising, Popular Release Monthly, 280 Fourth Avenue, New York.

YOU Are Wanted To Realize Miners at Home. Intensely profit making proposition, established 20 Write for information. Sprinkle Meter Co., Marion, Indiana.

WATKINS made $145 first day selling Cleaning System to doctors and merchants. Retails $4.50. Costs [illegible] $16.00 costs $1.50. Adjustment Assn., Mobile, Alabama.

$5 [illegible] and fast sales. Every owner buys gold initials for his auto. You charge $1.50, make $1.35. Ten orders daily easy. Write for particulars and free samples. American Monogram Co., Dept. 47, East Orange, New Jersey.

ANY salesman can sell them! Merchants everywhere use [illegible]. Separate sells fast, why not you? Collect big commissions daily. Samples, largest [illegible] Also wet [illegible] repairs. Lincoln Rubber Co., 8 S. Dearborn, Chicago, Dept. 72.

ANTIFREEZE prevents radiators freezing. Thickens the [illegible] auto cleaner polisher. Radiator [illegible] cleaner. Hand soap. Write for free shipping [illegible] profit auto specialties. Mickman Co., St. Paul, Minn.

AGENTS Making big Money Selling Fibre Brooms, Push Brooms, Dust Mops, Auto Sliver Dusters. Catalog and Samples Free. National Fibre Broom Co., St. Louis, Mo.

HIRE Yourself as Boss! $250 Weekly Easily Made Making Those Biggest Selling Specialties right in your Home. Room or Office. Have others selling them. Get $1 Valuable Literature describing Armalite Guaranteed Radiator Anti-Freeze Jiffy Cleaner $1 per can. Self-Lock Tire Reliables Automobile overnight Sells to Kind of Hand Cleaners; Tufts quadruples life of Silk Hosiery. Dustpol Unbreakable Automobile Polish; Many other Hottest to-produce Real Money-makers. Get those liberal profits which should be yours. Miller, Industrial Chemist, Tampa, Florida.

"Every 3,000 Miles This Amazing Little Device Buys Me a New Tire...FREE"

"THE money I save on gasoline more than keeps me in new tires. Figure it out. I was getting 13 miles per gallon on my Nash. With gas at 18c plus 2c tax it cost me $46 to drive 3,000 miles. Now I'm getting better than 36 miles per gallon. It takes just half the gas and I save $23 to $25 every 3,000 miles—more than the price of a new tire."

No matter what make of car you drive, the Stransky Vaporizer is unconditionally guaranteed to give you 50% to 100% more miles per gallon or it costs you nothing. As a matter of fact, it is not uncommon for the Stransky Vaporizer to more than double gasoline mileage!

Note These Records

Forty three miles per gallon from a Chevrolet, reported by F. S. Carroll. Fifty seven miles on one gallon in a Ford, reported by J. T. Jackson, Michigan. Forty miles per gallon in a Dodge from Brownsville, Tex., to Tampico, Mex., reported by T. L. Brown.

Proved by Two Million Owners

Records like these are reported in every mail for every make and model car from 72 different countries the world over. More than two million Stransky Vaporizers have been installed.

Easily Installed

No bigger than a dollar coin—no more expensive than a good wrench—no more trouble to attach than a fan belt! Attaches to the intake manifold of any car in five minutes. Anyone can do it.

43.8 Miles Per Gallon

Mr. M. E. Miller, Kansas City, writes: "You people claim a saving of 25 to 50% of Gasoline. I have subjected the Vaporizer to a severe and thorough test. After installing one on a Chevrolet I found I was obtaining 43.8 miles to a gallon whereas formerly I had been getting only 19.5. That is not a saving of 25 or 50%, but 124%, so you see that the actual test surpasses your claim."

Less Gasoline More Power

The vaporizer supercharges your gasoline after it leaves the carburetor. Completely vaporizes the gasoline. Under this ideal condition you get more compression out of less gasoline and a more complete explosion. Both power, pickup and speed are noticeably increased. Starting is not into [illegible] with as the Vaporizer automatically shuts itself off when the motor is idle.

Make This Test

Test the Stransky Vaporizer on your car—and expert results that will amaze you! Double your mileage, get flashing pickup and power—forget carbon troubles, sluggish motor and fouled spark plugs from over rich mixture—and save enough on your gasoline to more than keep you in tires. These results are guaranteed or the test costs you nothing.

Mail the coupon below for full details, guarantee, and amazing trial offer, which is even more remarkable than we can tell you here. There is no obligation whatever.

FITS ANY CAR IN 5 MINUTES

Any one can install this device in 5 minutes. Simply loosen one connection to the intake manifold with a wrench. You can do the rest with your fingers.

J. A. STRANSKY MFG. CO.

C-738 Stransky Block, Fulwana, South Dakota

J. A. Stransky Mfg. Co., C-738 Stransky Block
Fulwana, So. Dakota

Without obligation send me full details of your free trial offer.

Name

Address

City State

( ) Check here for Distributor's Sample Offer and the selling plan

$4 an Hour for Salesmen, Agents, and Spare Time Workers

Men are making wonderful earnings showing the Stransky Vaporizer to car owners in spare time and full time. Sells fast under our guarantee. Foster made $357 in two weeks. G. F. Fuller earned $114 in 5 days. Eberlein sold 23 Vaporizers in 35 minutes. J. W. Crook actually earned $51 in an hour. You should be able to earn at least $3 every hour you put in. We offer demonstrators one Vaporizer FREE, under our unusual offer. Get full details. Simply mail coupon at once.

Salesmen and Agents Wanted

[illegible] Wholesale Grocers, [illegible]

[illegible] Electric Advertising [illegible] Lighters. [illegible]

[illegible] samples free. Consolidated, [illegible] Van Buren, Chicago.

[illegible]

WE HAVE [illegible] William C. Bartlett, Inc. [illegible] Chicago.

[illegible]

[illegible] Scientific Laboratories, 1970 W. Broad, Richmond, Va.

[illegible] Wonderful Pocket Adding Machine [illegible] Pittsburgh, Pa.

[illegible]

[illegible] Manufacturing Co. [illegible]

[illegible] American Products Co. [illegible]

[illegible] Ohio.

[illegible] Christy, Inc. [illegible] New York.

[illegible]

[illegible] Chicago.

[illegible] $2 an hour [illegible] Write Mary [illegible] Chicago.

[illegible]

[illegible] Chicago.

[illegible] Fyr-Fyter Manufacturing Co., Dept. H, Minneapolis, Minn.

Ship Models

SHIP Model Building Profusely Illustrated; circular free. Marine Research Society, Dept. [illegible] Salem, Mass.

Stamps and Coins

STAMPS [illegible] all different [illegible] cents. Lists free. [illegible]

[illegible] William [illegible] Boston, Mass.

[illegible]

[illegible] Prospect Stamp Co., 401 Queber Ave., Toronto 8, Canada.

[illegible]

[illegible] Los Angeles, Cal.

Stories Wanted

[illegible] Popular Science Monthly, 250 Fourth Ave., New York.

Telegraphy

TELEGRAPHY [illegible] Popular Science Monthly, 250 Fourth Ave., New York.

Typewriters and Supplies

TYPEWRITERS [illegible] Pa.

Wanted

DETECTIVES needed everywhere. Experience unnecessary. [illegible] Write American Detective System [illegible] N. Y.

[illegible] Address Manager of Representatives, Popular Science Monthly, 250 Fourth Ave., New York.

[illegible] Ask today for a copy of the "[illegible] Art in Advertising Rate Folder." It contains [illegible] Popular Science Monthly Profitable. [illegible] Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Avenue, New York.

Romance Jams the Log Jams

(Continued from page 149)

match sticks, long saw logs that crashed on the rock-strewn river bed, up-ended rebelliously for a moment, then too were carried helplessly on by the unleashed water. On the dam the men with pickpoles worked like demons to keep the logs end-on to the current and running free, for a sluiceway jam is the meanest sort. As the boom began to empty a windlass was manned, with much shouting and singing, and the boom logs drawn in toward shore, thus herding the outlying logs toward the sluiceway. Soon the desired number had passed through into the river, and the gate was lowered.

Following this section of the drive three miles down river, we found the logs floating quietly in deep water behind Middle Dam, and in charge of a new crew. There the sluicing process was repeated. Sometimes a single drive crew takes the logs from the woods to the mills, but on the Androscoggin drive, and on most other big ones, the dams divide the river into sections, each manned by its own crew, which hustles the logs to the next dam and then lets the other fellows do the worrying.

After six miles of the roughest sort of white water driving, Rapid River hurls the logs into Umbagog Lake and they are towed into the Androscoggin River. The logs are sluiced through several dams, and there is plenty of white water driving on the Androscoggin before they reach Berlin.

"I WAS at this drivin' game for forty years, until the rheumatism made me a has-been," volunteered old Joe as he spun the starter of the outboard motor and we started back across Umbagog. "It's a tough life, but it's hard to keep away from it. On the Androscoggin and the Diamonds I've driven logs—and on the big 'moccasin drive' up in the St. Maurice country in Quebec. They call it the moccasin because you never see a pair of calked boots on it. Those Canadians up that way like to do their driving from canoes and them there batteaux of theirs—big flat-bottomed boats something like a dory, but with higher bows and sterns, that can go whoopin' through the darndest rapids you ever saw without takin' in a drop of water. Those fellers—there's a lot of Indian blood in most of 'em—are the best white water boatmen you'll find anywhere. They can make a canoe sit up and talk.

"You been in that country? It's tough workin' there—dead cold in winter, and mosquitoes and black flies to drive you crazy in summer. Up there they don't call the forests the 'woods' or the 'brush.' They call 'em the 'bush.' Fellers say they're goin' into the bush just like a sailor says he's goin' to sea. And it's just as easy to get lost in the bush as it is to get lost at sea. I've heard a pack of wolves howlin' not ten miles from La Tuque, the biggest town there—the jumpin' off place for the bush. The same company that runs this drive here on the Androscoggin has a big pulp mill there, and owns timber limits up the St. Maurice.

"How do those companies know which logs belong to them? That's easy. A brand is cut in both ends of every log. Up above La Tuque the company I worked for has the first sorting gap on the river. A long boom stretches across the river, and in that boom there's left a narrow gap. There's a platform built there above water level, and men working on it work the logs crosswise to the current, so the cleats on the endless chain of a power conveyor pick them up. On a higher platform sorters look at the brands. Logs that have their company's brand they push off into the water, where they are held by booms until the pulp-crushers of the La Tuque mill need them. The conveyor throws the other logs back into the river below the booms, and they float on down-

"You say (Continued on page 153)

Romance Jams the Log Jams

(Continued from page 151)

lumberjacks aren't what they used to be," I commented. "How are they different?

"Well," said old Joe, "there's a different class of men in the business. Used to be a man was a lumberjack and nothin' else. He worked in the woods all winter, and on the drives in the spring, and then when he'd get paid off he'd go on a bender for a couple of weeks, and then loaf until September, and go into the woods owing the company money for his outfit. But a good many of the fellers that work on the drives now-a-days are just laborers from the big cities. They don't take any pride in their business. Get their money an' get back to the cities.

But the real lumberjacks still spend their money prettty freely. Some of them blow it on booze and a good time. But the younger fellers don't do that so much. Clothes is their delight. Any some of 'em will come off the drives, and without waitin' to take a bath even will get rigged up in an outfit fit for a city dude. Maybe they're more moral than we used to be, but they ain't as good at breakin' down a jam, with the white water clutchin' at their legs and death hangin' over their heads. No, sir!"

A New Brood of Lindberghs

(Continued from page 30)

with him and if they, too, report his case hopeless, he is washed out.

Promotion to solo flying brings the reward of two flights a day—half an hour alone and then half an hour with the instructor, learning new maneuvers for the next day's practice.

The beginning of soloing brings the most thrilling experiences of all, but cadets are forbidden stunt flying. On a clear day this rule can be enforced easily enough, but when the clouds hang low it isn't so easy.

Along with his primary training in flight, the cadet has devoted part of each day to technical training on the ground. He has studied the airplane engine until he is thoroughly familiar with every part. He has mastered details of the rigging of airplanes. He has learned the principles of navigation and how to use navigating instruments. He knows how to send and receive signals by radio, and has practiced communication by hand and light signals and carrier pigeons. Even meteorology and some astronomy have been learned.

AT THE end of eight months he completes his primary training, and is a full-fledged flyer. There remain four months of intensive military training in the Advanced Flying School at Kelly Field, San Antonio. There he handles every type of service plane, from the speedy little pursuit ship to the giant multi-engined bomber. He practices military formations and evolutions, flying wing to wing with his comrades at 150 miles an hour. He flies through fog and storm, and tries his ingenuity at making forced landings in tight places. Perhaps, even, he experiences his first forced parachute jump, as did Lindbergh during his cadet days.

Not the least of his achievements is the ability to fire a machine gun and hit a target from his swiftly moving ship.

At the end of a year he has flown for more than 200 hours. He is an expert pilot, equipped to meet any emergency. Graduating, he receives the commission of second lieutenant in the Air Corps Reserve, subject always to the call to active duty, and is in line for a commission in the Air Corps of the Regular Army.

Whatever calling he may choose to follow, the year of strenuous effort and adventure has accomplished a two-fold purpose. It has raised him to a place of leadership in the ranks of aviation, and it has added new strength to the nation's air defenses.

Our Battleships on Wheels

(Continued from page 48

soon afterward German shells began dropping about both.

The next clear day another German buzzard came over, and then we got a bad dose day and night for forty-eight hours or thereabout. Guns 4 and 5 got the worst of it. First the buzzard dropped bombs near 4, then the Germans resumed their bombardment of Belleville and its bridge over the Meuse, near our position. Some of the shells struck within twenty or thirty feet of our berthing cars.

NEXT day, the 29th, three of our men were badly wounded. It was now almost November, and the Meuse valley was rainy and raw. We were afraid weather had affected our powder. If it got too cold, it lost its punch and wouldn't drive the shells so far. We decided to steam heat the ammunition cars and Gun 5 started to try it out. Steam-fitters among their versatile crew started to lay a steam pipe line from the locomotive into an ammunition car. They were working out in the open when a shell landed and hit A. P. Sharpe, K. W. Guthrie and A. J. Burdette. We sent them to the Army hospital at Glorieux. Next day Sharpe died, first of the crews of our battleships on wheels to be killed by the Germans. The others recovered.

On the day Sharpe died his gun, 5, started with 3 and 4 to even up by firing ten shots each into a mass of German troops concentrating at Mangiennes, about 25,000 yards away. Next morning Gun 4, back from the Laon front, reached Charny, about three miles nearer the Germans than Thierville. From there we fired our first shots at Montmedy, six, at 27,392 yards. The gobs went through a German bombardment while firing. Shells landed between the gun and berthing cars and killed three American engineers working on our track. They blew the headquarters car and one berthing car off the track, but we got them back.

But there was fun, too. Souvenirs were plentiful. Pretty soon we began to look like a war museum. I got a derelict French box car and put a gob in charge who took all souvenirs and issued checks. Thank God, the Germans never hit that car.

Liberty parties brought little stoves from deserted Verdun. Everything was all right until an Army general came around inspecting and asked where the stoves came from.

"General," I said, "the weather is getting wintry. A few days ago we had a heavy storm, and it just rained stoves. We shut all doors and windows, but a few stoves blew in somehow."

The general said no more.

NOW Marshal Foch was planning another great thrust to envelop Metz and throw a French and American force under our old friend Mangin and Lieut. General R. L. Bullard into German Lorraine, and on to the Rhine. Guns 1 and 2 were sent south and were ready to shell two important railroad centers, Hettedorf and Saarburg, when the armistice came November 11.

That was because of the great success of the general offensive starting November 1 in which Guns 3, 4 and 5 played a valuable part. At dawn that morning they started firing, and Gun 2 joined in for a while. Eighty-one of our great shells fell that day upon the two vital junctions of Montmedy and Longuyon. The Germans tried to use the railroads to the utmost, in reinforcing their wavering front, and our shells fell just when and where they were needed.

We fired an even hundred next day. The doughboys had broken the German center, and were pushing straight for Sedan. Now or never they needed support, and our battleships on wheels gave it. We sent for more ammunition, and we got

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Our Battleships on Wheels

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enough, though none too much. We had brought to France powder and shells for 300 shots by each gun, 1500 shots in all. We had fired nearly half and not all the rest was at the front.

On November 3, while Guns 1 and 2 were preparing to leave for the Metz attack, and 3 and 5 doing work necessary before firing again, there came a hurry call to fire on two smaller junctions at Loupoy and Remonville, respectively some 20,000 and 28,000 yards, where our aviators reported German troops concentrating. A German aviator over Gun 4 watched the whole process. That evening shells came close and fragments struck the headquarters car.

Gun 4 opened the ball between 1:50 and 2:30 the morning of November 4, dropping shells into Montmedy. German shells fell close again, and G. P. Butler was slightly wounded.

Meantime Gun 3 had sneaked up to Charny at two o'clock in the morning and fired fifty-six shots into the railroad yards and at the tunnel at Montmedy. Ensign W. C. Davis checked the aiming angles O. K., and Lieut. W. G. Smith, commanding Gun 3, was sure he had done something. He had. The lower yards at Montmedy were in flames. Our battleships on wheels were officially credited.

Brigadier General Hugh A. Drum, Chief of Staff of the First Army, wanted us especially to cave in the mouth of the tunnel. It was a small target, but on November 3 Gun 3 threw fifty shells into the town and yards. On November 4 ammunition was lacking. Next day the firing at our favorite target commenced again. Then came the beginning of the end. As General Pershing puts it:

"WE HAD cut the enemy's main line of communications. Recognizing that nothing but a cessation of hostilities could save his armies from complete disaster he appealed for an immediate armistice on November 4.

But Marshal Foch didn't quite trust the enemy and the Allied Armies kept closing their jaws and we kept on dropping our great shells into Longuyon, Montmedy and Mangiennes. We got off fifty-five shots and spent most of November 10 waiting for armistice news.

The next morning the war ended, and we sent over ten black periods to mark finis. They were all fired from Guns 4 and 5 upon Longuyon. Gun 5 stopped firing at 10:50, four minutes before the Armistice. Gun 4's last shot was fired two minutes later. Seaman James A. Kaffka worked the firing key. It was all figured out that the shell would land a few seconds before 11 o'clock, just under the wire. We gave the project to Admiral Earle, who had first inspected the idea of the battleships on wheels on November 18, 1917, just a day over one year before.

During our firing in the greatest American battle, there had never been an American airplane to spot for us. The Intelligence Service had sometimes sent us reports of results, and a German prisoner said he had seen one of our shells blow up a troop train, but as soon as possible we went to see results for ourselves.

Lieut. Hayden, a professor at the University of Montana, on November 12 went over to Montmedy through the German lines. The French people in Montmedy greeted him as their savior after four years of captivity.

One shell had hit the headquarters of the Seventh German Army and killed or wounded twenty-eight of the staff.

We had hit the tunnel three times, but had been unable to cave it in. That was because the delayed action fuses had not yet come from the States. The next day Commander Runkley and I went to Loupoy and Remonville and found

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Our Battleships on Wheels

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fourteen shell holes about thirty-three feet in diameter and eight to eleven deep, two right in a former ammunition dump and most of the rest within effective reach of the railroad bridge midway between these two towns.

We had cut the main German strategic railroad in the decisive stage of the greatest battle in American or world history. General Pershing wrote me after the Armistice:

"Permit me to express to you and to the contingent that served the naval guns under you my sincere appreciation of the very efficient manner in which they cooperated with the artillery of the A. E. F.

"Your command has performed a distinctly important service, and I found you at all times eager to carry out our plans in a true spirit of cooperation.

"I should be very glad to have you express to all concerned my sincere thanks and appreciation for the work accomplished."

I PASSED on this praise with interest to those who well deserved it, Commander Bunkley, Commander Schuyler and all the other officers and men who helped so loyally.

Well, the war was over. Now for Peace and Home. We went back to Haussmont and the night of November 23 we had a big movie show and on the spur of the moment, I talked a little to the men.

"After our experience," I said, "there will never come into my mind any question about the American manhood meeting any situation. After we had finished the Battle of St. Nazaire I knew this outfit would go to Berlin and nothing would stop them—but the Germans have given in and we are going home.

"In all our joys and gaieties, in connection with this performance here, we must not forget those men of this force who started out just as full of this as we did, but who have fallen by the wayside. It is not possible for a bunch of people to tackle all the things we have tackled without somebody getting hurt. But I am happy to say that all three of these men were hurt directly in the line of duty. They are:

"C. G. Russell, lost in Philadelphia.

"Thomas E. Price, died at Mailly from walking typhoid.

"A. P. Sharpe, killed at Thierville by a German shell.

"I ask you all to rise and sing with me that famous old hymn, Abide with Me."

One thing all those gobs wanted before they went home was a good look at Paris, and I thought they had it coming. The Parisians, too, wanted to see our big guns that they had heard about, so on November 28 my flagship train put off for St. Nazaire—via Paris—and the five gun trains came along after. We drew crowds that stared as if now they began to understand why the Germans had quit.

ON DECEMBER 10 all the trains had returned to our old battleground, St. Nazaire. Within a week all but one officer and twenty men, left to dismantle gun cars, were on the ocean homeward bound. With my executive officer, Commander Bunkley, and most of the men I reached New York Christmas Eve, 1918. My only regret was that I must say good-bye to so many true-hearted comrades who had made successful an enterprise such as few sailors ever undertook. One of my keenest pleasures now is in foregathering with one or another of them, as I often do.

I like to recall our inland voyage, and to remember that as a result of it, my country is the better prepared against attack in another war. For far at sea, a hostile fleet would be struck by shells of even greater power, fired an even greater distance by bigger guns, drawn by trains moving more swiftly—thanks to what we learned on the land cruise of our battleships on wheels.

A definite program for getting ahead financially will be found on page four of this issue.

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hour. Jack Page figured he must have passed off the end of the point, and out to sea, long since. And he had.

The third hour of flight brought nothing of improvement. If the fog would only break for a second, merely give Jack a peek at the sun's position.

Something else went wrong—Cheese came to a standing lean in the gangway and listened.

Jack's heart stopped and his eyes went to the instrument board. "Trouble travels in mobs!" Jack barked. "The Liberty's burned out her generator!"

For a minute, the high note of the *Pacific Gull's* three-toned drone had fallen. Then, before the Liberty could quit entirely, Jack had switched her ignition over to battery. For an hour or so, the motor would continue to operate on that source of supply. But, after that, with the Liberty "it's" twenty-four plugs sparking from one small battery, the juice supply would become exhausted. Then the silenced motor, weighing at least 1500 pounds, with radiator and oil tanks, would become a heavy, useless thing.

WHEN the fourth hour ended, the sun was still among the missing; so was the Liberty, and it was "missing" badly. The dampness had gotten to its ignition, and the big motor vibrated and shimmied through every plate and rivet of the all metal *Gull*. Jack Page knew that motor wasn't going to be with him long. Also, he realized that to keep it running might mean damage to the genuine feet hours of the other motors. But to kill the Liberty meant to carry its dead weight. Then, with four hours gasoline supply gone, the other two engines would operate only one more hour at the most. Jack came to an all metal, large-sized decision. He would try something that no other pilot had ever been put to. he decided not to carry that dead motor.

For a minute he and Cheese talked. Then the latter secured tools and took on a big job—a job of daring.

Cheese went through the small, forward cabin door and across the cat walk to the nacelle of the right wing's motor. There there, he leaned down and unfastened the draft wire which ran upwards to the Liberty's radiator bed. Then, with the wing end of the draft wire, he made his way back to the ship and entwined the free bit of the line through the exhaust manifold. Meanwhile Jack was running all motors at half-speed.

NEXT, Cheese freed the four hold-down draft pins which held the motor heaters to the nose bulkhead. With the safeties freed, Cheese lightly tapped all four pins until they were ready to slide. Then, moving across to the left wing's nacelle, he loosened the second draft. And with this wire in hand he returned to the left door of the cabin, crouched just inside, and waved an O.K. back to Jack.

Then Jack Page undertook the thing that no pilot had ever before tackled. He slowly eased full-power to his two wing motors and won a little more altitude. Next, even slower, he palmed the Liberty's throttle wide-open, and she vibrated beautifully! When the Liberty was shaking the ship as no ship had ever been rough-housed before, Cheese mapped the left draft wire forward and into the whirling propeller. With a sickening jolt, the propeller shattered and rattled its broken bits forty ways against the all metal surroundings. With a murderous vibration set up, the craft pulsed wildly in every plate—seemed as though it must be torn to pieces. Another wrenching and tearing, and the thing was over. The Liberty had been shaken out! And the [illegible] checked it in. Broken-blade vibration will do it every time.

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With the great weight gone, the nose came up. Quickly, Jack whirled his automatic stabilizer's adjustment wheel and made the longitudinal correction. Then the *Pacific Gull* sailed blindly into the fifth hour.

"You win, Jack," Cheese said. "Thought she'd konk us!"

During the fifth hour, visibility over the water became better; and it was early in this hour that Jack spotted a ship, a great black liner coming head-on.

"That's a *Maru* boat!" Cheese cheered. Then, a minute later—"And she's the *Tokio Maru*. . . . I know that baby; I've seen her in Frisco a lot."

"Well, that's good and not so good," Jack answered. "If she's headed for San Francisco, then we've been flying for Japan. And if she was three hundred miles out early this morning, she's still farther out than our gas'll stretch."

JACK turned the *Pacific Gull* about, took his direction from the ship's, and started for where San Francisco should be. Then, after a few minutes of flying and thought, he turned back and headed directly for the *Tokio*. Cheese said, "What the h—!"

"Slide in here behind the controls," Jack told him, "and fly in circles above the *Tokio* while I talk to the passengers."

Jack passed a word to the girl and went forward through the companionway. Upon reaching the lady and her three boy friends, he stopped for a moment and assured them that all was better than well. Which was a lie, and Jack knew it.

Upon reaching Mr. Deuss and the four government men, Jack ganged them close together. He pointed out the *Tokio Maru* and talked earnestly.

"These seat booths," he said, "are cork-loaded and self-righting. You might get a little wet, but that's all. It's a cinch I can't carry this load ashore, so, you'll get wet anyway. What do you men say?"

"Listen, pilot," Mr. Deuss said, "You're captain on this ship, and what you say goes. If you say this thing is the only way out—hop to it. Tell my little girl good-by. And I'll meet her in San Francisco."

"And you?" Jack asked the government men.

FOR a few seconds they grinned strange grins and looked from one to the other. Then, as one, they said "Shoot! You promised to get us to the *Tokio Maru*, and we'll tell the official world you're doing it!"

Thirty seconds later, Jack was back on the controls.

He spoke to Cheese, and at the same time reached to his instrument board and opened a small door behind which were ten short levers. Each lever was numbered. "Go forward," Jack said, "and amuse the lady and her husbands. . . . Keep their eyes to the rear. Then explain what happens in your own apt way, Cheese."

For a few seconds, Jack studied the drift of the *Tokio's* smoke. After climbing two thousand feet, he flew slightly up-wind from where he had last seen the water craft below the clouds.

In the cabin, Cheese once more checked over the safety belts of the five men who had wanted to reach the *Tokio* in a hurry. Next he moved to a position behind the four rear-seat passengers and attracted their attention by starting an extemporized lecture on the advisability of looking to the rear when flying in clouds. He held their eyes. The five men up front held tightly to their seats.

Jack Page reached out and pulled five small levers. In the cabin, five square sections of floor clicked back (Continued on page 162)

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into place, and the remaining four aerial wanderers wondered at the great empty space where, seconds before, five noisy men had sat and talked.

"Where are they?" the lady demanded of Cheese. And she pouted at where they weren't. Her three men echoed the question.

"Where are they?"

"Ah," Cheese smiled. "That is the question. They've gone down to the lower deck for a smoke."

"I didn't know that there was a lower deck," the lady exclaimed.

"It's a big ship," Cheese answered. He went through the companionway. And said: "Yes, the *Tokio Maru* has many decks."

"One . . . two . . . three . . . four . . . five," Cheese counted as he gazed down over the cockpit's gunwale. "They all got away, Jack, and with clean openers."

"Parachutes!" the girl discovered. "Where did they come from and who are they?"

The nearest one to our tail, Jack told her, "is your dad. The other four are carrying the government boys. They're going down to the *Tokio Maru*. That comes of being in a hurry."

"But run," the girl cried, "why was I sighted? I have always wanted to ride a parachute."

"MR TOO," Jack laughed, "but it's a thing that can wait. I released those parachutes when I sprung these levers," he explained.

"But the parachutes," the girl asked, "where were they?"

"The parachute to each seat is packed away under the central walk. When the hatch drops through the trap door, it drags its attached parachute out for a positive opening. The idea is Cheese's. Alas, Cheese had the idea that laymen must be dumped."

Circling down, Jack brought the *Pacific Gull* up over the *Tokio's* stern. Already the parachutes had been sighted and the big liner pulsing by the white foam along her sides had reversed her screws and was standing by. On the boat deck there was much activity as something was on its way down from the davits. The Japs were prepared to pick up the jettisoned five.

REMEMBERING his own troubles, Jack Page again judged his line of flight from the *Tokio's* lurch and he trailed into the east. Looking back, just before the clouds once more blotted out the scene, Cheese cheered: "Some shooting, Jack—some sharpshooting. I'll say! You put Mr. Deuce right into the *Tokio's* rigging! There's another right in near her bow. The third down mast-high. And the other two a few hundred feet astern."

"I should have dumped the others," Jack now decided. "The whole thing went off so smoothly. But I knew they'd yell like murder if I told them what to expect. We'll have a chance now though. If we can't make land, the *Tokio* will be along to pick us up; that is, if our flotation chambers work as they should. . . . And it won't be long now because our gas is just about out."

"Maybe you're closer in than you think," Cheese suggested. "And perhaps we'll make it yet."

Maybe, Jack mused, is a good aeronautical word. But maybe gasoline never kept any plane on the wing. *If* we do it, Cheese, it will be God-sent, and I don't mean maybe."

"Another ship!" the girl shouted. She pointed dead ahead. Out front, a few miles, a something was plying its way shoreward.

When they could ascertain its color, Cheese placed the brownish-red craft as a Matson boat. "The (Continued on page 159)

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Hilo," he decided. "That's the boat that our lady friend and her three yes-men want to make."

"Cheese," Jack said, "go forward and take a look at four safety belts. I promised her I'd get them to the *Hilo* in time, and I'm as good as my word." Quickly, the willing Cheese was gone.

"And what about little me?" the girl asked. "Do I go bye-bye this time?

"Not so's you'd notice it!" was Jack's backwash. "Nix!"

Everything's set," Cheese came to the passage and reported. "and all four are still looking up. Want me to show them the way down, Jack?" As he spoke, he was making ready.

"Want to go, Cheese?" The question was foolish.

"Every pound counts, Jack; and I'm no lightweight. What's more, you have no real use for me. . . . I'll go down and have the *Hilo* wireless the Coast Guard to be on the lookout for you."

"SO-LONG, Cheese"—they shook hands—"and have the *Hilo* on the lookout, too. Get into that seat. We'll be up wind from the boat in a shake. Step on it!

Seconds later, they were abreast of the steamship. Jack made a few brief remarks to the girl at his side and pulled five more small levers. With her head hanging from the cockpit, "One . . . two . . . three . . . four . . . five," the girl counted. "They've all opened."

Back over the *Pacific Gull's* tail surfaces, Miss Deuss continued to watch. "They're lowering a boat . . . . Two are down just behind the ship . . . A third just ahead . . . The other two behind, so close I can't see them . . . . Good shooting! Fine sharpshooting, I'll say, Jack Page!"

"Oh, boy!" Jack grinned. "I'd sooner be up here than down there in Cheese's boots when that old girl is fished out."

"You and me both," the girl smiled. "Think they're still looking up? Or do you suppose they've caught seasickness from too much free air?"

They wanted the *Hilo* in the worst way," Jack grinned, "and they got it."

"In the worst way," she added.

FOR a while the *Pacific Gull* droned shoreward. Jack studied his instrument-board telltale glasses.

"I don't know what she's flying on now," he mused, "because, according to the glasses, all the gas is gone. . . . It's ten after four. And still she carries on. All metal, my ship is! And her motors and spirit, too."

"To say nothing of her pilot," the girl added. There was a long silence.

"I have one more card to play," Jack said at last. "If the *Gull* is all that she should be, she'll cruise on one motor. If she won't, then you and I must get set for a wetting."

"If you built her that way," said the girl, "then she'll do it."

Jack cut the switch of his right motor, the wing fell a little till he "picked it up" with left-rudder, then the *Pacific Gull*, at reduced speed, cruised on. "That will save half of what gas is left—if any," he said. "Miss Deuss, hold the lobe of your left ear and wish. . . ."

"Look!—the shore line!" Jack pointed. The clouds to the east were on the blow. Now and then they lifted. And, here and there, the mainland came into view; it was perhaps twenty miles away. "Now is the time, *Pacific Gull*," Jack exhorted, "to prove that you are with me, and believe me, *Gull*, you're a goose gosling if you don't do your stuff now!"

Silently, tensely, Jack watched the direction of wind-ripple. (Continued on page 160)

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on the water below; it showed that he was being favored with a tail-wind—a breeze from his rear which would help carry the *Pacific Gull* through these last few tight miles. "Everything a-coming our way," he said and told the girl of his latest good luck. "It's like the drowning man and his straw, Miss Dee."

"First name—Almira. 'Al' for short," the girl told him.

"Well, Al—we're like the drowning man we'll reach for anything now."

"Well, reach for that shore, Jack, and reach hard," Almira—Al Dean urged. "But if you don't reach, Jack. . . . My! what a man-sized try you've made!" Her voice, like all else, seemed slow.

In the ages that followed, there were slow miles for the hard-put *Pacific Gull*. At last, with only a few more miles to go, the single motor konked, flatly, and almost quit. Quickly Jack dropped the left wing lower—to drain all possible gasoline toward the dying power plant—and, with a new bark, the engine came to life. In the gas-lines, perhaps, a few pints remained.

"THIS is what I call being hard-up," Jack told Almira, "and if you could handle the controls, I'd go forward and squeeze the gas tanks for a few more drops." But even never quit the nearing shore, and he asked: "Al gosh, girl, this is the time and place for the augmented orchestra to strike up 'California, Here I Come', and they'd better hear down heavily on—Just Open Up That Golden Gate'."

A flock of shore-scavenging gulls were taking their evening knock-off from work on the beach sands of San Francisco's long Pacific waterfront. All attention, they watched and wondered at something that came a-fluttering toward them across the wave crests. Then, with a wild worry, they took wing and quit the sands to make room for a real gull. The *Pacific Gull* came a-rushing!

For the last few hundred yards, Jack Page came in on his ship's glide. The lone motor had gurgled and gone out of business for keeps. But gliding momentum, plus her flotation chambers, plus the aqua-dynamic force that carries a surf-board atop the crest, all joined in toting the great, spent *Gull* high and dry upon that deserted strand.

The Coast Guard crew came running. At first the guards thought there was only one person in that aft cockpit. Coming closer they learned that two can sit as close as one—and on the same control seat.

HOURS later the *Hilo* made port. At about the same time, the *Tokio Maru* nosed into her berth. And, among the 'chute-delivered ten, there were no snoreheads. Even the potent lady with three men was not displeased with the adventure. "Thrilling!" she avowed. "In all my life, no trip like that!" But her husband, it seemed, had caught a cold from his immersion. "His own fault!" the lady told everybody aboard the *Hilo*. "When we came to California—two weeks ago—I warned Horace against removing his flannels. But he would be a sport, and now look at him!"

Cheese was sore, too. He had undertaken to teach a number of the *Tokio's* brown boys one of our foremost national games. The session on knees came off in the forecastle; and the little brown cousins had taught Cheese a few things that he had never before dreamed of.

Not many days passed before Cheese, in a San Francisco hangar, had a gang busy with the rehabilitation of the all metal *Gull*. Early one morning, Jack Page came in to tell them to take their time.

"Do this job right," he said. "There's no rush now. When I get (Continued on page 161)

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back we'll hit the ball and start all over."

Then he said good-bye to the gang. Jack was on his way to England and the Continent; bent on the study of foreign airways . . . and other things.

"He sure has the flash of a tin god!" one of the mechanics remarked when Jack had gone. "Some brassy bird! Imagine this cloud-buster walking off with Big-Man Deuse youngest kid.

"And making the old man like it!" another wailed. "Old Deuse and all his jack! . . . My gosh! what a cast-iron crust this steely guy has, and with all the high mucky-mucks in the Southwest trying to capture Almira."

"Tin god! . . . Brassy bird! . . . Cast-iron and steely." Cheese Farling came out of a cockpit feet first to exclaim. "Well, I'll say you guys is right -all you say. all metal is what Jack Page is, brothers, all metal!"

Why We Are Immune to Some Diseases

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exercised rats were ill, and five of them died

Ten guinea pigs were well fed, ten put on reduced diet and ten actually starved. All were then infected with pneumonia. The starved pigs were given all they could eat and only two died. The well-fed group got all they could eat and five died. But the reduced-diet group got no food after the infection, and seven died

"All of which seems to show," concluded Dr Spaeth, "you may be safer against infectious diseases at those times when you are putting on weight than when you are in the pink of condition after a period of training or exercise."

Antibodies are of two kinds—those that attack the bacteria themselves, and those that attack the toxins, or poisons, produced by the bacteria. The latter antibodies are called antitoxins. The former are divided into three groups—some kill the bacteria by dissolving them, others "clump" them and still others simply "eat" them. These are called, respectively, lysins, agglutinins and opsonins.

THE Schick test for diphtheria immunity is probably the best known. A tiny amount of diphtheria toxin is injected under the skin. If a red, inflamed area appears, you are susceptible—your blood contains no antitoxin antibodies to neutralize the poison. If you are immune, no mark at all appears on your skin the antitoxin within you has immediately neutralized the injected toxin

Dr Famulener endorses four rules to protect yourself against contagious diseases.

1. Find out by test what diseases you are immune to. Your doctor can test your immunity to diphtheria, smallpox and scarlet fever. If you have ever had typhoid, cholera, smallpox chicken pox, scarlet fever, measles and mumps, you are probably immune to these

2 Immunize yourself, by vaccination or inoculation, against diseases you are not immune to. A list of the sicknesses for which successful immunization has been found has already been given in this article.

3 Avoid channels of infection, as directed by local boards of health in times of incipient epidemics.

4. Observe general hygienic rules, particularly in regard to cleanliness, sunlight and fresh air.

And you can't do much else against germs than follow these rules, the doctors warn. You can't escape them. Between 1400 and 15,000 microbes enter your nostrils in one hour's tranquil breathing. The only thing to do is to forget them, and hope that the fighting chemists and bacteriologists some day will perfect methods of immunizing against all infectious diseases.

Sperry—Competitor of the Sun

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enough to let the flywheel rotate inside the ring without touching it. And this circular rim was itself held in bearings in a "Y." But the bearings of the ring were a quarter of a circle or ninety degrees around the ring from the bearings of the flywheel.

This is a gyroscope, and except for size and driving power behind it, it isn't any different from the gyroscopes which are used in navigation," he said. "A gyroscope is simply a flywheel so mounted that it is free to rotate in any direction, instead of one direction only."

He wound a string around the axle of the flywheel and gave it a smart pull, and the little wheel spun like a top. "Try to turn it over by pushing against the rim," he said. I was surprised at the resistance offered by the tiny mechanism. I turned the "Y" standard around and the spinning wheel flopped over, end for end.

"THE principle underlying the gyroscope and its applications is that every rotating body tends to revolve on a fixed plane in space and resists every effort to change its plane of rotation," he explained.

The plane in which the gyro rotates is a plane in space, which has no relation whatever to the earth itself. It will keep rotating in that plane if permitted, regardless of the movement of the earth beneath it. Put it afloat, as in a ship, and it will always know where the center or axis of the earth lies with reference to itself.

It occurred to me that if a mariner could always tell the exact direction from his ship of the axis of the earth, he could tell in what direction he was heading. The gyrocompass points always to the true North.

The gyrosteering device and the gyrostabilizer utilize the gyroscope's resistance to change. Metal Mike, as the gyro helmsman is called, steers by the gyrocompass, which tells him the course. Every wave, current or puff of wind which diverts the ship's head from the true course gives Metal Mike a shove, and he shoves back, just as a human quartermaster would. But he is much more sensitive to the least variation from the compass course and his response is quicker.

The gyrostabilizer is sensitive to the first impulse of the first wave, and gets into action instantly, steadying the ship before the second wave has a chance to get in its cumulative effect. Thus it takes only weight and force enough to counteract the effect of one wave to keep the craft on an even keel."

A Japanese cruiser of 16,000 tons, taken out in a heavy sea for a test, rolled twenty degrees each way without the gyrostabilizer and less than two with it.

THE plans now under way for a fleet of enormous passenger ships to run between England and America in four days flat call for their equipment with gyrostabilizers, Sperry told me.

The first application of the stabilizer to airplanes was perfected in 1913. Sperry and his son Lawrence—later lost flying the English Channel—equipped a Curtiss plane with a gyroscope and sent it to the Aerial Security contest in France in 1914. The plane was flown with no other control, and a man walked out to the end of one wing without deflecting it. This "automatic pilot," as the French called it, won the grand prize. Out of it developed the idea of the aerial torpedo, which is simply a pilotless airplane, carrying a load of high explosives, directed toward its distant target under the guidance of a gyroscope. Seven of these, built during the war, hit targets thirty-five miles distant in tests. The Armistice came just as production in quantity for use at the front was beginning.

"When did you first think of entering into competition with the sun, Mr. Sperry?"

"Now you are going back a long way," he smiled. "Back to the very beginning of my career. And that started in Chicago, in 1880, October 14th—my twentieth birthday. That was the day when the Sperry Manufacturing Company turned out its first electric dynamo, and its first arc lamp."

I drew out enough of the story of his boyhood to account for the man facing me now. A Yankee boy from the oldest New England stock, motherless, brought up by his grandparents in Cortland, N. Y. "A nuisance to the neighbors, I'm afraid," he laughed, "making toy windmills, pestering the men in the sawmill and the machine shop until they let me use their tools. I blew up one boy with an experiment with benzine vapors, but fortunately he was not badly hurt. Another time I set a neighbor's back porch on fire.

HE WENT to Cornell University for one year of physics and engineering and decided how to make an electric generator twice as efficient as Gramme's dynamo which supplied the current for Brush's electric arc light, one of the marvels displayed at the Philadelphia Centennial of 1876. Local business men put up the money and before he was nineteen, people were flocking in to see his miracle.

Chicago was the place for a young man, the boy decided soon, and there he went. He built a tower—the highest in the world, three hundred and fifty feet—on top of the Board of Trade Building, and put 40,000 candlepower of arc lamps on top of it. It was thirty years and more before the incandescent light finally supplanted the arc for street lighting, and through all that time Sperry was trying to make an arc lamp with more light and fewer shadows.

He did it, finally, by putting a mineralized core into the positive carbon. On heating, this produces a substance known as carbide, which has a boiling point of 5000 degrees Fahrenheit. Carbon boils at 6700 degrees, and at that temperature gives off 160 candlepower of light per square millimeter of heated surface, and that is all the light which can be obtained from any solid at that temperature. In the Sperry arc as high as 1200 candlepower per square millimeter has been obtained. The sun delivers to the earth only 980 candlepower for each square millimeter of its radiating surface, so the Sperry arc is literally brighter than sunlight.

IT WAS the fame which his early feats in electric lighting won him that led to his being invited, in 1884, to join in organizing the American Institute of Electrical Engineers. Later he called the meeting which resulted in organization of the National Electric Light Association.

He won first prize in a competition for improved mining machinery devising the first electrical equipment for mining coal, still used extensively. One piece was an "electric mule" with such powerful traction that a street-railway magnate asked Sperry to devise an electric street car which would climb hills. He did that, too, sold out his Chicago interests in 1889, and moved to Cleveland to manufacture street cars. Myron T. Herrick, now Ambassador to France, was treasurer of that Sperry Electric Railway Company which soon sold out to the General Electric Company.

Sperry then turned to making electric automobiles and in so doing developed a storage battery so capacious that it became the foundation of a business which is still going on.

Versatile, inventive, the traditional Yankee inventor type in its highest development he is but a name to the general public, because of his personal modesty and diffidence.

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Coal Too Useful to Burn

(Continued from page 49)

Moreover, the new process is combined with another process for making ammonia an important ingredient of fertilizers. Both processes involve subjecting coal gas to pressure of 15,000 pounds to the square inch and pumping it through steel tubes containing catalysts.

A catalyst is a substance which induces or hastens chemical actions of others. The catalysts make the coal gases form methanol (wood alcohol) and ammonia.

Here is an example of what may be expected from coal:

Several years ago chemists discovered that carbolic acid and formaldehyde mixed and heated under pressure form a solid material now called bakelite after the inventor, Dr. Baekeland. Used for pipe stems, radio dials and panels, distributor heads on automobiles, insulation, fountain pen barrels and so forth, bakelite and similar products have largely displaced hard rubber. Commercial manufacture of "cheaper" wood alcohol from coal will lower the production cost of bakelite because formaldehyde is made from wood alcohol. Bakelite will then be thoroughly a coal product and so even floor tiles may be made from coal!

Like a brick mason, the chemist rearranges the elements—carbon, hydrogen and oxygen—of which coal is composed, to build what he will that is composed largely of any or all of these elements—theoretically, even rubber.

Probably the most interesting recent development is the manufacture of oil and motor fuel from coal. The United States, possessing abundant natural supplies of petroleum, has surrendered the lead in this to chemists of Germany, France and England, where the natural supply is limited.

Four processes have been developed

IN THE first, the coal is heated to a cherry red, at about 1400 degrees F., which drives out most of the oil and gas. The solid residue is an excellent smokeless fuel, resembling soft coke. The twenty-five to thirty gallons of tarry oil obtained from one ton of coal may be "cracked" to yield five or six gallons of a gasolinelike motor fuel. About 5000 cubic feet of rich gas is also obtained from one ton of coal.

The second method, the Bergius liquefying process, changes from thirty to fifty percent of the weight of the raw coal into oil. Powdered coal mixed with enough oil or tar to form a thick paste, is pumped with hydrogen gas into a steel cylinder, producing a pressure of 5000 pounds to the square inch which forces the hydrogen into combination with the coal, converting it from a solid to an oil. From 100 to 140 gallons is obtained from a ton of coal and refined into gasoline, kerosene, fuel and oils.

Refining of the oil to produce gasoline is obviated by "catalytic" processes developed by the Badische Company in Germany and by Pelart in France, to make a pure synthetic motor fuel direct from coal gases. Water-gas, made by passing steam over red-hot coke or coal, is pumped up to enormous pressure and passed through copper-lined steel tubes heated electrically to a temperature of about 750 degrees F. Zinc and chromium compounds in these tubes cause the gases to form methanol. A ton of coal yields about 125 gallons, two gallons of which will drive an automobile as far as one gallon of gasoline. Estimated manufacturing cost, however, is between twenty and thirty cents a gallon, hence it is out of the picture for automobile fuel at present.

Dr Franz Fischer of Germany is producing the most interesting of all these synthetic fuels. Recently he exhibited true gasoline, lubricating oil and solid paraffin, all made from coal. He passes water-gas over catalysts consisting of iron and cobalt heated to about 550 degrees F

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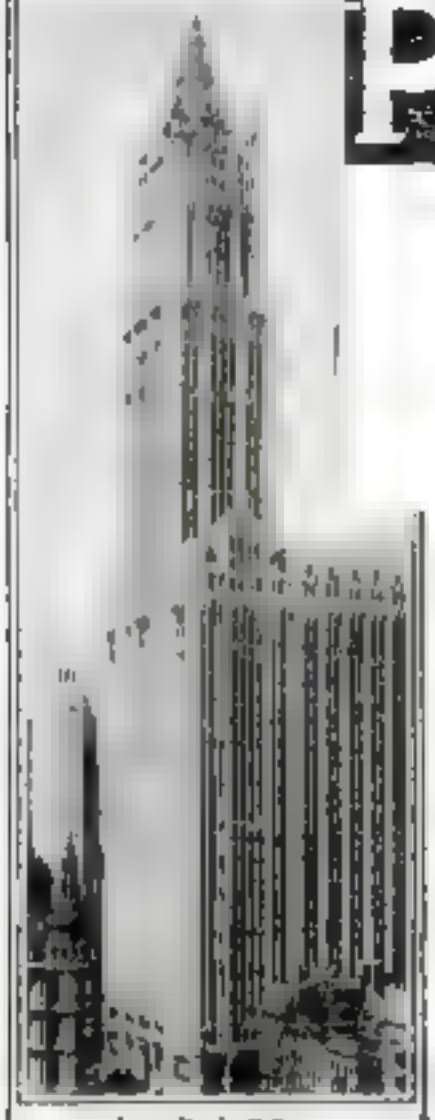

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Here Are Correct Answers to Questions on Page 63

1. The town of Hammerfest near the northern extremity of Norway. Settlements farther north in Spitsbergen and at Etah, Greenland, are not large enough or permanent enough to be called towns. In a straight line Hammerfest is only about 1300 miles from the North Pole.

2. The quality of the milk used and the care taken in the churning have combined to give Danish butter a world-wide reputation. It is sold as a luxury almost everywhere, even in Australia and New York.

3. Off the mouth of the Amazon River, whose power takes it that far.

4. In Australia the government, in order to recognize certain native tribes to the laws against wife-beating, whips wives for husbands who can prove them guilty of wrong doing. The same law applies to guilty husbands.

5. The large variety of one-shelled sea snail known as the abalone is an inhabitant of many of the shores of the Pacific Ocean, especially on the Isla de Cedros or "Isle of Cedars," on the west side of the Bay of Sebastian Vizcaino.

6. This is true of Sitka and to some extent even of the city of Juneau, a little farther north. A current of warm water flows across from the coast of Japan and warms the Alaskan coast.

7. Goldfish of the colored varieties do not live wild anywhere in the world. They are raised for market, just as fine dogs are. The largest goldfish farm in the United States is near Martinsville, Ind. The fish also are raised in large numbers in Maryland, Iowa, and Kansas.

8. This curious name is given to the flat, lakelike expanses of hard clay that are encountered in the desert parts of California and Nevada. In most cases these clay plains really are the bottoms of ancient lakes.

9. These the famous Lake Magadi, south of the town of Nairobi in Kenya Colony. This lake is a small, dried-up remnant of a larger lake. At the bottom is a bed of crystalized soda of the kind known as washing soda. It is shipped to Europe.

10. This word comes from two Greek words and means literally with the feet opposite. It is given to the countries directly on the other side of the earth from northwestern Europe, especially Australia. The reason for this name is the fact that people living on the opposite side of the earth from us have their feet toward ours.

11. In China, Japan, and more or less generally throughout the Far East, religious persons write prayers on paper, which is then burned in a ceremonial fire. It is possible to buy in the market places bits of bright colored paper on which prayers have been printed in advance, all ready for use.

12. In the year 586 B.C. Nebuchadnezzar, King of Babylon, captured Jerusalem and burned the famous temple, which had been built nearly 400 years before by King Solomon. The temple was utterly destroyed. Even the site of it was forgotten. It is now believed, however, that it stood on the crest of one of the hills, called the Eastern Hill, of the modern city of Jerusalem. The temple probably stood not far from the so-called Sacred Rock, over which now stands the Mohammedan building known as the Mosque of Omar.

The Movie Maker

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approximate locations he was to find and photograph. He also informed Bean that he had wired for reservations on a fast boat between New York and Liverpool.

That evening Don hurried home, whistling thoughtfully. In his pocket was the signed lease and contract, running for four months. At the conference in Eckstein's office that afternoon, Margaret Moreland had appeared and, much to the surprise of the president of Popular Players, had added her signature without protest. As Don climbed the two flights to his attic apartment, his mind was busy with schemes for the immediate raising of further cash. He had sold Margaret's sapphire ring that morning for six thousand dollars. Reluctant to accept aid in such a fashion, he resolved that even if the picture failed he would eventually repay her. But now it was to her advantage, even more than to his own, to throw everything into the balance for immediate success.

HE STEPPED into his apartment quietly, unnoticed by the professor, who was deeply absorbed at a long table near one of the windows.

Don's home could be called an apartment only through courtesy—or imagination. In reality, it was a workshop where he and the professor slept. Originally it had been the ample, undivided third story of a huge old house in a dilapidated section of Los Angeles, but Don had partitioned it into a small bedroom and a very large, unadorned studio. One windowless side was boarded off into a dark room. On the north side, he had cut a large square out of the roof and constructed, with fair skill, a ground-glass skylight.

All about the big room was a clutter of photographic background screens, motion picture lighting standards and paraphernalia, and an orderly tangle of electric wires. The most interesting parts of the studio, however, were the professor's long worktable and the shelves he had built against the wall near by. The old man's interest in the technical side of motion pictures apparently had burst into full bloom that night, three years before, when Don had unexpectedly met him coming out of a neighborhood picture house. Since then, Professor Mahlenburg had spent hours every day making perfect miniatures of motion picture scenes and properties. Three shelves were crowded with ancient ship models. Filling three other shelves was a zoo of perfectly constructed animals of every sort and description, including tiny prehistoric monsters. Painted masks that seemed grotesquely alive stared down from the top shelves.

ON A long table, over which the old man was bending so intently that he had not heard Don enter, was a clutter of wheels, steel spirals, and miniature machinery. Peculiar geometrical designs cut out of metal disks or paper mache were stacked loosely at one end of the table. On a small rack before him were arranged a dozen disks of a different type, each a little larger than a silver dollar, but of varying thicknesses. Some of these were glass, but the majority were fine pieces of gauze or transparent silk drawn tight in little metal rings. The professor was examining a similar disk under a large microscope clamped to his table.

He looked up triumphantly when Don spoke.

"This one dried perfectly," he announced. "My Gretchen will look like sixteen when we use it on the lens."

He placed the disk in the rack with the others, took from his eye a small magnifying glass he wore like a monocle, and smiled mysteriously at Don.

"I have a surprise for you, my son," he remarked.

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Only slightly interested, Don waited while the professor put on his spectacles with great ceremony, fumbled at length in his pocket, and drew out a long slip of paper. He handed it to Don.

It was a certified check, signed by Otto Mahrlenburg and payable to Donald Kennedy, for twelve thousand dollars!

Don stared blankly from the check to the professor and back to the check again. Yes, it was certified! But where could the old man have obtained such a sum? He had been nearly starving when Don had taken him in, and he apparently had no friends. While living with Don, he had worked up a small business of amateur kodak picture finishing, making enough for his small expenses and for the materials needed in his model making. But he could have saved no money. Don was sure.

YET the professor was smiling blandly, as though accustomed to giving away thousands of dollars every day.

"It looks real," Don commented, rubbing the check between his fingers. "It feels real, and, by golly, I believe it is real, but how in the——"

The professor seemed slightly embarrassed. "My daughter——"

"We can't take any more from Miss Moreland!" Don interrupted.

"This money my daughter deposited for me in a bank years ago," explained the old man with dignity.

"You mean you could have had it three years ago when you were practically starving?" asked Don incredulously.

The old man drew himself up in injured pride. "It is for the father to support his daughter, not the daughter her father," he declared. "Now only, can I use it because it will be for her——"

* * *

September first. Cinema City was almost depopulated. Two or three smaller independent companies continued production there, but with the big units of Regular Players gone, the place looked deserted. At one end of the lot, however, several workmen were erecting ten-foot wooden supports in the form of a huge circle. From this group a long-legged young man, his red hair flaming in the sun, walked rapidly across the lot to Stage No. 4. He hurried inside the big shed to a dismantled set where three of his little company awaited him, dressed in medieval costumes.

"Fine!" He looked them over critically. "How does it feel to be an actor again, Jerry?"

"Right this minute I'd like to be zooming five thousand feet up, with a cold wind blowing me through the clouds." Jerry wriggled uncomfortably in a heavy costume of chain mail. "This is not my idea of a Palm Beach suit."

"We'll start shooting right away," Don promised. "Only a few close-ups today. Miss Moreland, are you ready to run through a scene? I'd like to see how Jerry registers."

WHAT he really wanted, however, was to test a combination of lighting effects and the professor's lens screens on Margaret. He had watched her work under other directors and believed that the strained expression of her face was due partly to her fear that she was failing. Now, chatting casually about the very modern and highly efficient mechanical equipment of the stage, he apparently concentrated on Jerry, asking Margaret occasionally to help the greenhorn actor put across his scenes.

The play was a story of the great war, with Jerry an aviator and Margaret an English war nurse in France. This was only the shell of the story, however, for when Jerry crashed just behind the enemy (Continued on page 169)

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lines and crawled out, wounded, to lose consciousness on no man's land, his hallucinations took him back to another life—to England of the twelfth century at the time of one of the Crusades, when he was a Norman noble and Margaret a Saxon lady. The action of this central part of the story concerned Jerry's adventures as leader of a band of crusaders. To be near him, Margaret disguised herself as a knight, taking Judy, her little maid, along as a page. The journey through England and France, over the Alps, across the Mediterranean to Constantinople, and on to the siege of Jerusalem, gave an opportunity for a spectacle motion picture of colorful adventure. Boso Biddle and his camera were to collect the local color and send it back in cans of film across the Atlantic, while all the actual adventuring was to be done on the lot at Cinema City.

THE sequence Don had chosen for his test was designed to take place near the castle in old England. To control his lighting effects, he had decided to photograph the scene on a three-sided box set of Stage No. 3, lined with heavy white muslin. As he set the camera in position, he called Jerry's attention to the huge electric light bulbs, protected by wire housings, which were mounted on a bridge above the set.

"That's why I chose this stage," he explained. "It's the only one on the lot equipped with incandescent lamps in place of the carbon bridge lights. Stand here, will you, Jerry?"

"But think of the juice they'll use," objected Jerry, taking his place about six feet in front of the camera. "Wouldn't carbons be much cheaper?"

"Not when you figure salaries," explained Don, squinting at Jerry through the finder. "There must be a man to every two carbon lights, as well as chief electrician, and we pay at least ten carbons for any interior, sometimes eighteen or twenty—Miss Moreland, will you take your place here?—and the men are on the payroll eight hours a day, even if we use the lights only fifteen minutes. But one man can operate the whole row of electric bridge lights. That'll save us thousands of dollars."

"Edison again to the rescue," murmured Jerry.

Satisfied at last with the camera angle, Don handed Judy a tape line. While she held it even with the lens, Don stretched its length to Jerry's nose, then stooped and chalked a rough semicircle on the floor. Cautioning them not to step outside the mark, Don moved to the switchbox at one side of the set and threw on the full blaze. From the scaffolding above, thirty thousand watts of electricity rained down on them, flooding every square foot of the set with even, shadowless illumination.

AND then Don began to paint out the lines and hollows of Margaret's face with additional light. A baby spot, focused to spread its rays just below her chin, removed a wrinkle with painless surgery. A bank of mercury lights, placed low on the other side to throw back a counter light against the downward glare from the bridge, erased the laughing lines from her nose to the corners of her mouth. The tiny crow's-feet about her eyes, the faint vertical lines between her brows, no light manipulation could remove, Don knew. These he left to be ironed out by the microscope diagonal threads of the professor's screen. Stopping it into place over the lens, he called for action and began to crank the camera. Next week he would have a camera man, but for the first few days he wanted to test every operation himself. A few days and several hundred feet of film sacrificed for experiment at the beginning of the picture would save weeks of delay and thousands of feet from being wasted later.

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Jerry and Margaret, with Judy appearing briefly now and then, ran through their scene lightly, with a good comedy touch. Don grinned appreciatively as he observed Jerry putting in bits of action that had not been rehearsed. He had no fear for Jerry's performance. The man was a born actor. Entirely without self-consciousness, his thoughts translated themselves into action and facial expression without effort. And being blessed with a keen sense of humor, he enlivened any scene in which he appeared. Don wondered if the leading man might not unconsciously steal the picture from the star. But Margaret was playing up to him with a dash and animation that revealed an unknown phase of her ability as an actress.

LATE that afternoon the five met in the projection room to see the first rushes of the big picture, and a little sigh of pleasure sounded in the darkened room as Margaret's face appeared on the screen. Firm, rounded, alive with vivacity, the beautiful face looked as though a kind hand had swept over it, smoothing out all telltale lines and hollows. But who was the ghastly-faced man playing opposite her? Only the sparkling dark eyes were Jerry; the rest was a flat dead mask, grimacing.

"What is the matter with him!" groaned Judy.

"Too much make-up," murmured Don.

"But we had to lay it on thick," protested Jerry's disappointed little sister, "he's so dark."

When the lights went up, Jerry faced the others with an apologetic grin.

"If I had any vanity," he remarked, "I'd go out and shoot myself. Now I see why I never got any farther than doubling for the handsome hero."

"Come over to the stage again," suggested Don. "I'll try some more shots if you don't mind. No need for the rest of you to stay."

For three hours, until even Jerry's tanned and toughened skin began to feel tender, Don made up his face with different shades of grease paint and powder, shooting a few feet of film for each new make-up—heavy pink, flesh, chalk-white, pale yellow. One test he made with Jerry's skin in its natural state. This showed the best results in the projection room next day. But even so, though the ghastly effect was overcome, he looked as swarthy as a Mexican laborer.

"That'll be fine when he doubles as his villainous half-brother," commented Don, finding a ray of hope in the gloom.

"YES, but how are we going to fix him up to look like the hero?" asked Judy, almost in despair. In rewriting the scenario so that Jerry could play the double rôle of hero and villain, she had congratulated herself on saving the salary of an additional actor. Now it looked as though a new leading man must be hired.

"Why not have Louis Menzies disguise his face?" Margaret suddenly suggested.

"The make-up wizard?" asked Don.

"Yes. I want him to help me with my own, too."

The worried five piled hopefully into Jerry's car and set out for a small dark building in Hollywood where for ten years a little man with stubby fingers had been practicing his art of shining the stars whose luster was fading: bringing back the peach bloom of youth with the right shade of grease paint, straightening crooked noses with a shadow pencil, concealing scars, and imparting natural curves to flat, expressionless lips.

Louis Menzies frowned and shook his head when he had seen the tests.

"You couldn't fade him out successfully," he indicated Jerry, "even if you whitewashed him."

"What can we do with him, then?" asked Don, as despair settled over the little group.

Louis Menzies was fumbling among the boxes and bottles on his shelves.

"Use this." He handed Don a stick of dark ochre grease paint.

"But it's almost brown!" protested Don. "He'll look like the end man in a minstrel."

"Use it!" commanded the wizard, and turned his attention to Margaret.

"Rouge a little lighter and toward the outer edges of the eyes," he suggested, "about here." Tilting her chin, he turned her face toward the light and dabbed her cheek bones near the temples with a puff filled with rose-pink rouge. "It will take away that little flatness caused by lack of shadows."

"And this young lady," he looked at Judy, "must use a pale flesh grease paint."

"But I'm almost as dark as my brother," she remarked, wonderingly.

"No matter," replied the great man. "We expect women to have white skins on the screen—and your eyes will look twice as large and like black velvet."

Louis Menzies' facial prescriptions were followed exactly, and the next day's rushes showed a new and handsome Jerry, with clear, olive-tinted skin.

"SOME sheik," exulted Judy. "They'll have to deliver his mail in bushel baskets when the lady fans see our picture."

But Jerry relieved that his face was no longer delaying production, gave his sister a rude shake and hurried out to more important business on the lot with Don.

Within the circle of supports erected the week before was stretched a huge canvas, like a topless circus tent. Waiting outside was a man with two beautiful chestnut horses. Jerry took the bridle of the larger one.

"You might tether the other in the shade of that tree over there," he told the man. "Miss Moreland won't need it for an hour or so."

Following Don, Jerry guided his horse through a flap in the canvas. In the center of the ring the new camera man, Timothy O'Day, was adjusting the tripod of a revolving, motor-driven camera.

"All set?" asked Don, walking over for an inspection.

"Just about, Mr. Kennedy. I'm ready to focus now."

"Hop on, Jerry," instructed Don, "and walk your horse around as near the canvas as you can get without bumping it."

Jerry did as requested. The camera lens followed him slowly around, keeping him in the center of focus as he made the circuit.

"Now trot."

Don set the revolving mechanism at a faster pace and, as nearly as he could judge, it kept the lens still centered on Jerry.

FOR nearly an hour, without exposing any film, Don and the camera man adjusted and readjusted the mechanism and rehearsed the action, timing it with a stop watch, while Jerry put his horse through its paces at several distances from the camera, but always making a complete circle around it. On the film, of course, he would appear to be riding along in a straight line. Don had figured out the scheme as a short cut for a "running shot"—a scene usually photographed from an automobile following along beside horse and rider.

When they were ready to make the exposures they sent for Margaret. Dressed in a long, flowing gown, with a veil flying from the high peak of her medieval head-dress, she entered the inclosure on the other horse. They rehearsed the

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sequence quickly with her, keeping strictly to the time allowed for each bit of action. Finally Don was satisfied.

"All ready, Tim," he said, taking his place at the camera man's elbow. He would have to remember to stay there in order to keep out of line with the swinging focus of the lens. Lifting a small megaphone to his lips, he called to the two on horseback at the outer edge of the circle

"Ready—action!"

Toward evening the little company gathered in the projection room for the day's rushes. The first shipment of films from Boss had arrived the day before and Don had them also thrown on the screen. Hundreds of feet of English countryside with a grim old castle frowning in the background; a bridle path along an ancient moat and following a brook, a sunny lane with daisies nodding at either side; a wide road with giant oaks arched above. But not a sign of human being or habitation except the ancient castle, occasionally looming large in the foreground. The camera now and again caught a rabbit scampering across the lane. And once, in his swift flight up the broad trunk of an oak tree, a bright-eyed squirrel paused for a curious second to stare into the lens.

THEN on the screen appeared two figures riding on horseback apparently miles and miles against a blank white background. Judy giggled nervously

"They look so—so uncanny riding along in space," she commented, "as if the earth had suddenly dissolved and left them sticking up in the air"

"Tomorrow you'll see them in England," promised Don.

Though he had spoken with such assurance, that night at home in his dark room he worked with tense anxiety to make his words come true. Would his precious machine, on which he had spent years of labor and thousands of dollars, fail him now that the moment for its big performance had arrived? It had proved out well in tests, but Don was acquainted with the occasional perversity of inanimate objects. In the early stages of his invention he had all but sold a half interest in it for two thousand dollars. At the critical moment, however the machine had unaccountably balked, and before Don could locate and rectify an innocent looking little screw the entire process had been thrown out of alignment a sixteenth of an inch, ruining the demonstration. Don's prospective partner had departed with his two thousand and a hearty laugh.

In the silence and dim red glow of the dark room, only the excited breathing of the professor could be heard as he helped Don with the developing and printing. But in Don's memory that laugh echoed. He set his jaw and his hands moved more deftly. Some day that laugh would be worth half a million on the credit side. Two or three pictures like "The Crusader," and motion picture producers could not fail to recognize the enormous economy of his universal background device. Two or three pictures—if successful!

BUT there was no time to be dreaming of that now. Using a homemade machine, he put a positive print of the horseback scenes taken that morning through a strong solution of silver nitrate, allowing the film to soak in the solution until the figures of actors and horses became intensified as black silhouettes on a white transparent background. In order to preserve the original background negative sent from England, Don had had a duplicate negative made from it at Popular Players laboratory This he intended to use in making his combination negative.

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intensified print of the horseback scenes was dry, he took a strip of unexposed positive and adjusted it on his machine. Over it he fastened the English background negative, and on top of that he placed the print of the silhouetted figures on horseback. Tightening the delicate mechanism of his device, an intricate elaboration of an automatic printing machine accurate to a ten-thousandth of an inch, he ran the three strips of film together through the printing process.

The result was a positive print of the English background with the blank outlines of horses and actors superimposed upon it, the silhouettes formerly black now showing up white and transparent when the print was run through the developing hypo. After allowing it to dry on a revolving rack in front of a large electric fan, Don placed this new positive over a fresh strip of negative film, and on top of the two adjusted an ordinary positive of the horseback scenes. Repeating the double printing process, he obtained a perfect combination negative showing Jerry and Margaret riding against the English background.

IT WAS two o'clock when Don held a few frames of the completed negative against the ruby light and with a magnifying glass noted the exact placement of the figures. Enlarged on the screen, not the slightest deviation would show. Now to make a positive print to run in the projection room the following day.

The professor had been gently snoring for hours in the next room, but it was dawn when Don, too happy to know he was tired, tumbled into bed.

In the busy days that followed, however, many problems called for solution. Boso had shown almost a genius for finding locations to fit the action of the romance. His timing records, faithfully included with each reel sent across, were models of accuracy and Don had little trouble synchronizing with them the action shot against blank backgrounds in Cinema City. Occasionally when the action involved an impossible combination of actors with background, Judy was called upon to do some rewriting. Usually it was a simple matter, but one day she rebelled.

"I can't rewrite this scene, Don—there's no way to do it! Jerry's just got to leap the chasm or we'll miss the big thrill we need at that point."

"I know it," agreed Don. "But I don't see how it's possible to track our way this time."

JUDY studied the still picture Boso had taken from the bottom of a deep gorge. The two sides of the ravine rise up sheer against the horizon, the top apparently two hundred feet above the level of the camera.

"We might find a location something like it in one of the canyons around here," she suggested.

"Can't waste time hunting for it," argued Don. "Besides, I don't like to have Jerry take the risk of leaping such an ungodly hole."

"I don't either," admitted Judy. "Let's ask the professor if he can't help us out."

Professor Mahrlenburg had appropriated one of the deserted stages as his workshop, and there they found him supervising the construction of combination large and miniature sets drawn to scale from the photographs Boso had sent of interior scenes, the courtyard, and the drawbridge of the old castle. At one side of the workshop, near a large window, an artist was reproducing part of a photograph on the upper portion of a large glass screen set in a wooden frame.

"Let me keep the picture and study it," the professor said, when they had explained their problem. "Maybe I can manage, but I must first work it out on paper."

Two days later, under his directions, a small model of heavy

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cardboard, burlap, and artificial foliage, with tiny trees at its base, was set up near one end of the lot. It was a four-foot replica of the gorge, but extended not quite to the top shown in the photograph. This omission was supplied eighty feet beyond the model and directly in line with it where the professor had two sturdy platforms constructed, fifteen feet in height, the distance between them apparently a continuation of the tiny gap between the sides of the model in the foreground. Over the platforms the professor carelessly draped rough grass mats, holding them in place with several large stones, a small log or two, and bushes. The platform at the right extended beyond the camera angle into a runway upon which Jerry's horse could get a good start for the leap. A painted back drop behind the platforms completed the set.

When Jerry was ready, Tim O'Day, with the camera six feet away from the miniature set, found the focus.

"Take a squint at that," he said to Don. "It's tricky."

AND when the day's rushes appeared on the screen, it proved "tricky" indeed—a perfect illusion. Jerry reined in his galloping horse at the very edge of the chasm, apparently a dizzy two-hundred-foot drop. For one breath-taking moment the splendid creature balanced there, his forefeet high in the air. Then he whirled and galloped away. Again Jerry urged him on and the horse took the chasm in a mighty leap.

* * *

The end of September was rushing toward them with the speed of an express train when Don, immersed in the rapid solving of each day's difficulties, suddenly saw the Big Problem looming immediately before him. It was Saturday noon and he had just finished passing out the weekly checks to their small number of employees. Judy was waiting for him in the office when he returned to discuss a slight change in one sequence. But his sudden glimpse of the Big Problem had shut everything else out of his mind.

"Judy!" he exclaimed, sitting down at the table beside her. "We've just three thousand left and next week I've got to send Bosco more money and pay the electric light bills!"

"So I've been thinking," replied Judy. "And what are you planning to do about it?"

"Gosh!" Don mopped his forehead with a limp handkerchief. "Thought I'd have the picture far enough along by this time to show it to some millionaire and get him to buy a share in my invention."

"AND what millionaire have you in mind?" asked Judy.

"No one in particular." Don looked troubled. "The truth is, I got so absorbed in making the picture I forgot all about the money end of it."

"Well, even if you did know anyone with money—and you don't," commented Judy ruefully, "no one could make head or tail of the picture in its present state."

"I know it," groaned Don. "Guess I'll have to drop everything for a while and find some other way to sell shares in my machine."

"And get cheated out of your rights in it!" scolded Judy. "Don Kennedy, you're no business man!"

"The man's have it," agreed Don mournfully. Leaning his chin on his hand, he slumped against the table for a discouraged moment.

Judy gave him a motherly pat.

"How would you like to have fifty thousand dollars?" she asked brightly.

"Don't be a piker!" Don groaned at her cynically. "Wish for a million."

Judy considered him with thoughtfully narrowed eyes.

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"I know a girl who wants to get into the movies," she announced casually.

"Do you know any girl who doesn't?" jested Don. "But maybe your friend owns a beauty contest cup!"

"Oh, no. You can get that kind by the barrel." Judy dismissed the multitude with a shrug. "My girl owns a father—and her father owns a string of newspapers from New York to San Francisco!"

"Silas Rogers" exclaimed Don. "I heard he was coming to Los Angeles to start a new evening paper."

"He and his daughter are here now," Judy informed him. "We lived in the same town when Mabel and I were little, so I looked her up when the papers announced her arrival. Mabel's dying to meet you!"

"Oh, so you've got the scheme all laid out!" Don looked at Judy suspiciously.

"I HAVE! It's about time someone thought of money," replied his defiant scenarist. "Mabel's father is taking her to Everglade Grove next Tuesday night and the five of us are just going to happen in and Mabel will invite us to their table and—"

"And we'll take the fifty thousand and tip the head waiter!" quoted Don. "Your scheme sounds weak to me, but maybe you can put it across. You'll have to count the professor and me out, though. No clothes."

"You can buy some!" Judy retorted tartly. "That's why I'm giving you till next Tuesday. Get a tux for yourself and a swallowtail for the professor—with all the accessories."

"No." Don's tone was final. "My cords and the old blue serge will have to do me till we get this picture out of the woods."

"Then you'll never get it out of the woods! If you want to be successful you've got to look that way. Jerry's getting a new tux, Margaret has promised to deck herself out like the Queen of Sheba—and I think you'll like my new dress." Judy smiled with pleasant self-approval. Then she turned a severe frown on the shabby young director. "Don, for once in your life you've just got to look decent!"

"Thanks for the implied compliment," Don replied, unsmiling. "But I'll wait till I can spend my own money for clothes. Don't forget that I'm living on your brother's charity and using Miss Moreland's money for the picture!"

JUDY stared at his unrelenting chin, at his grimly steady, tired eyes. Suddenly and quite unexpectedly, she had to gulp back a sob. She blinked her eyes quickly.

"I'm just trying to help you," she quavered. "It'll cost only about two hundred dollars to buy those clothes and give us a chance at the fifty thousand—and if we don't get the fifty thousand, what good will the two hundred be to us? We'll be sunk! You've been grubbing along for five years and—"

"And I haven't put anything across," Don finished for her grimly. "I guess you're right at that. The only way to get ahead is to throw a big bluff!" he concluded bitterly. Then he laughed at the meek little face opposite him—so unlike Judy's usually saucy expression. "Oh, well, I'll give your plan a try. Tell me what you want me to do."

"Attaboy!" A rainbow of smiles broke over Judy's face. "Now we'll get the picture on its feet. You can't expect anyone to back you till you put up a front!"

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